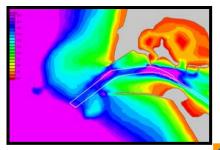


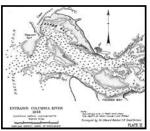
Sustaining Deep Draft Navigation at the Mouth of the Columbia River,



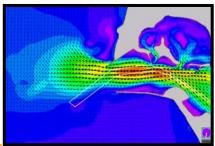
Oregon and Washington



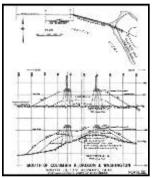


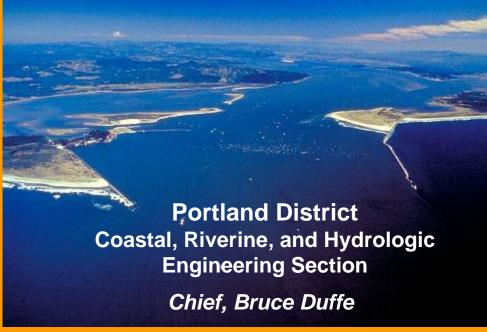
















Presenter: Rod Moritz

Presentation Elements

Jetty Construction & Inlet Evolution

Impacts of Shoal Evolution

Present Jetty Repair Activities

RSM Demo at MCR

MCR Environment

Columbia River Jetty System





11 Jettied Entrances

(Including Mouth of Columbia River)

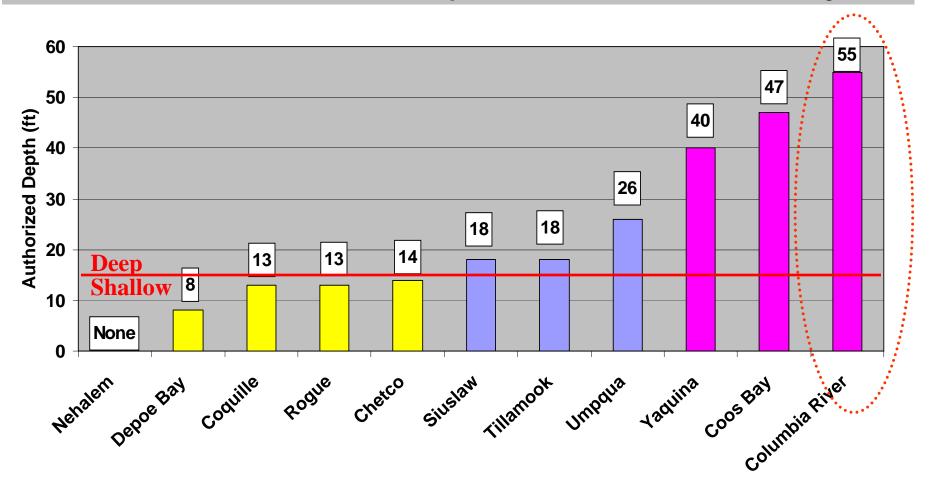
30 Miles – Rubblemound Structure

Construction - \$1.3 B

Repair - \$580 M

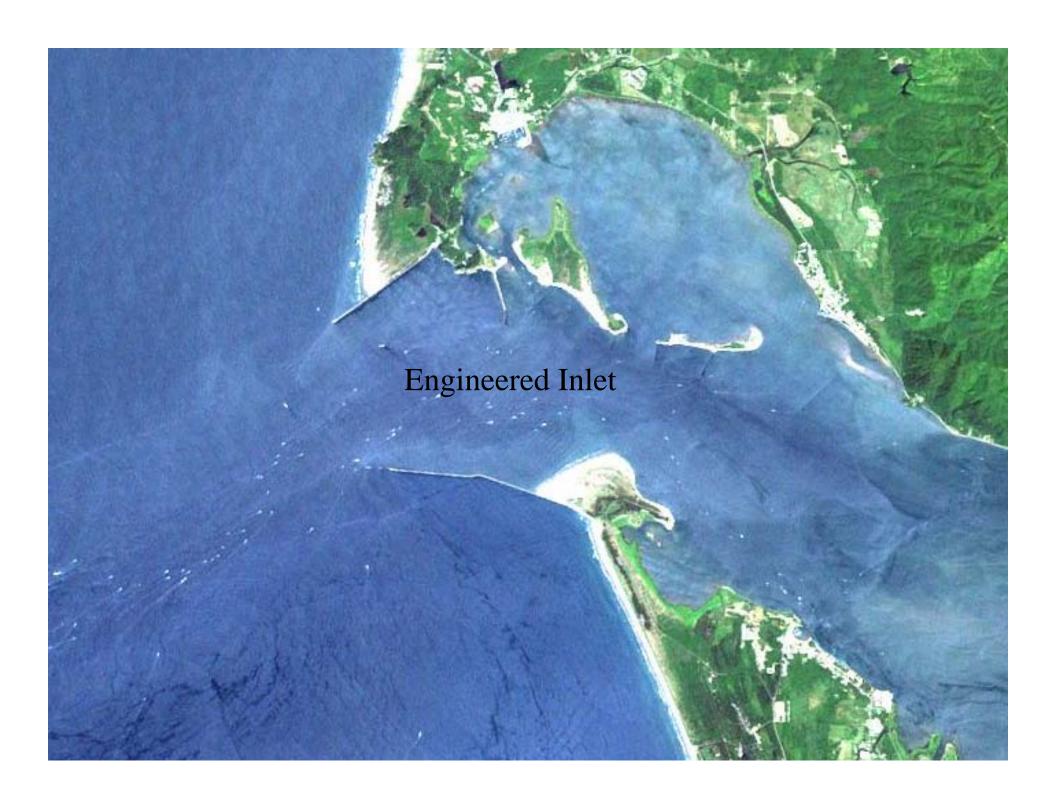
Armor Size – 10 to 50 ton

Authorized Entrance Channel Depths at Portland District Projects



While > 50% would be classified as "deep" draft by Corps guidelines, majority fall into small port classification in terms of vessel usage and economic output.







Mouth of the Columbia is a Symbiotic System of Navigation Structures and Morphology

Submerged Sand Shoals are the foundation for 100-yr old jetties and control the circulation at the entrance

1 mile + of combined jetty head loss has impacted the sand shoals at MCR, dredging requirements, jetty stability, and shore erosion

Improved Management of Dredged Material (placement) can Stabilize Sand Shoal Erosion, defer expensive jetty repair, feed the littoral system, and optimize Channel Maintenance program.

Regional Sediment Management

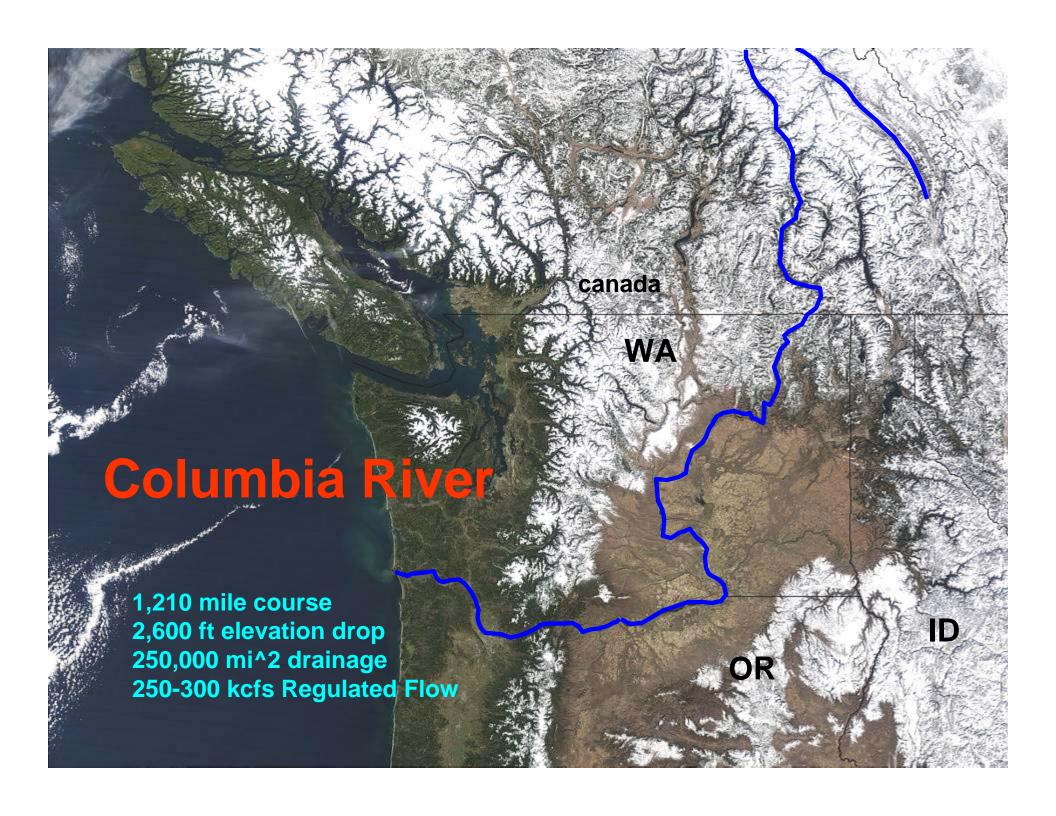
RSM is a *systems-based approach* for managing projects involving sediment.

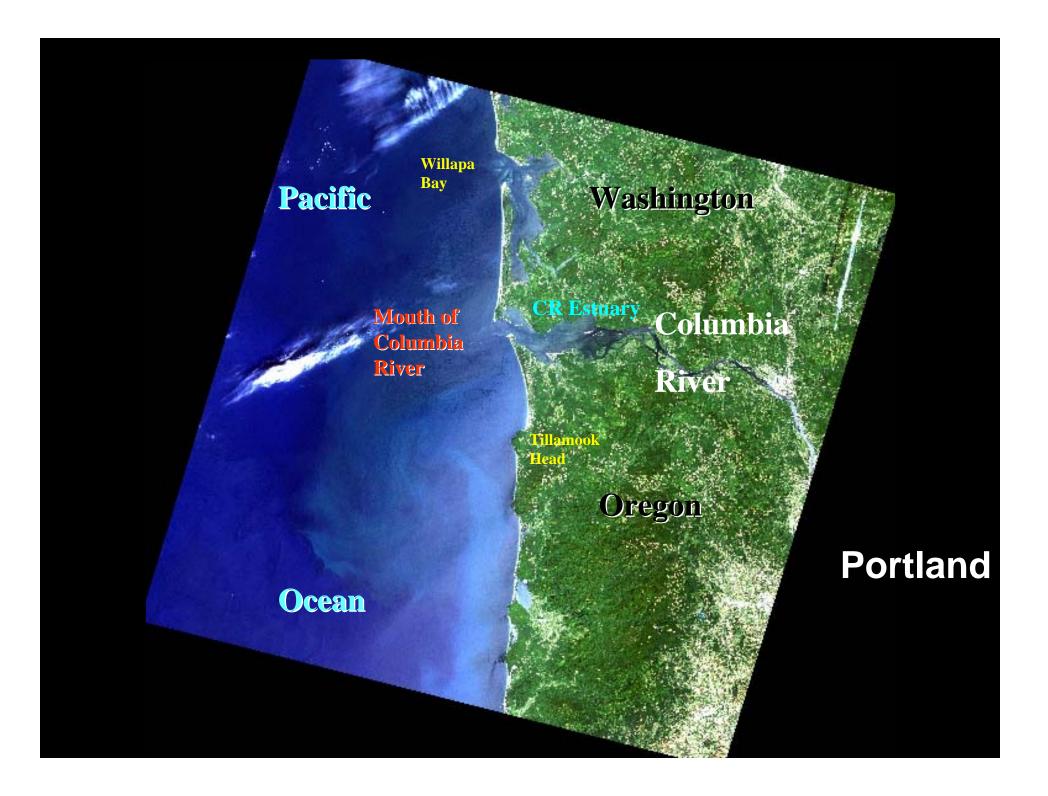
Sediment is viewed as a natural resource

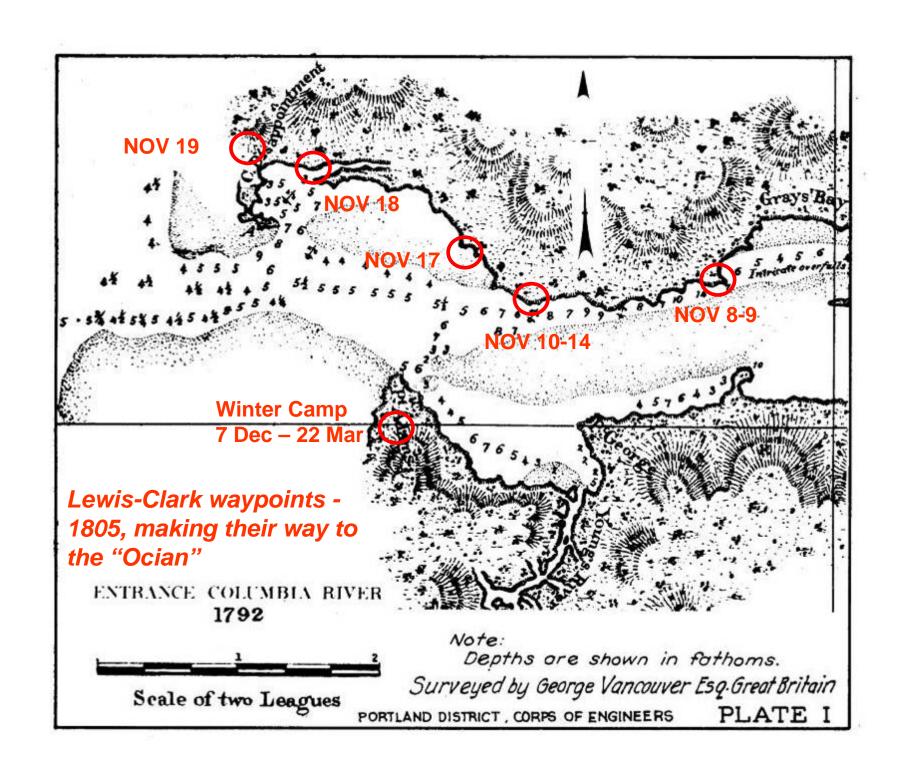
RSM fosters balance between projects and natural system processes: Resulting in reduced project costs and achievement of greater benefits.

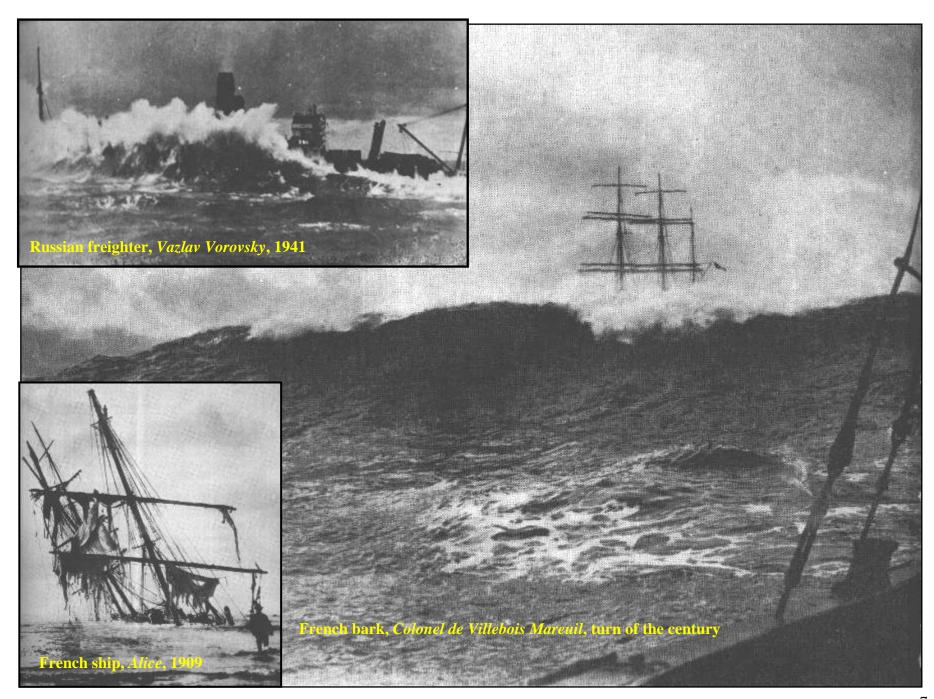
RSM broadens the "planning horizon" for projects by considering the extended time-space scale as defined by natural sediment processes.

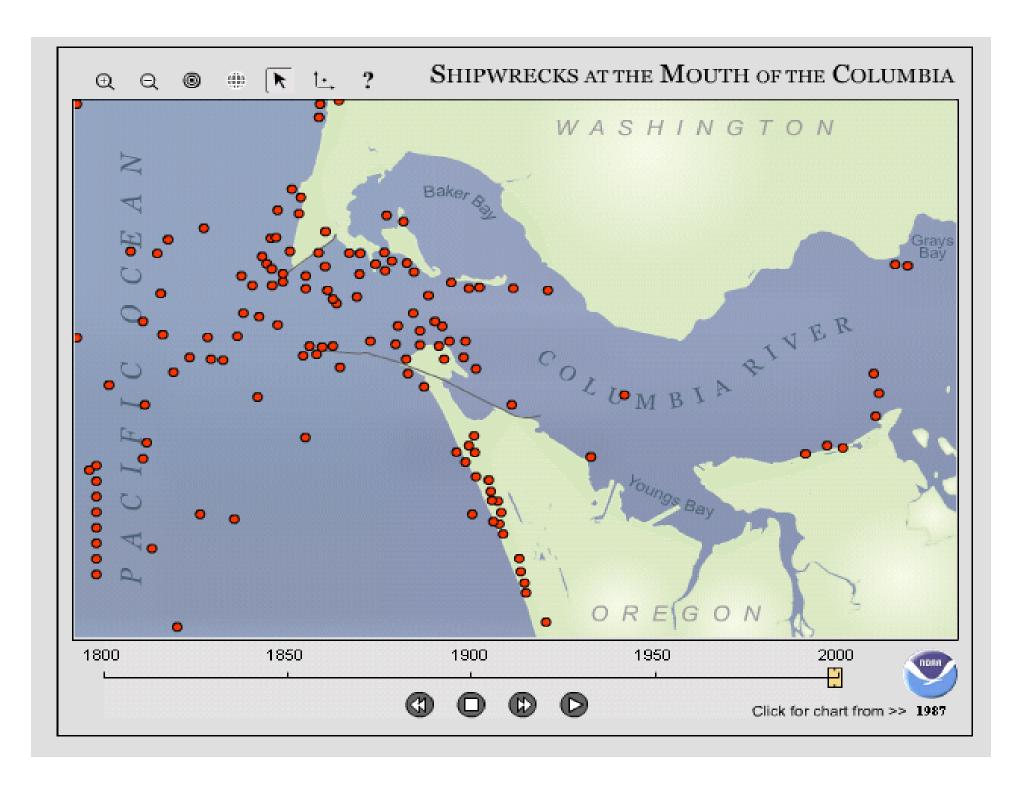
RSM requires full *collaboration* among agencies, levels of government, and stakeholders.













MCR Channel (RM -3to 3): Annual O&M Dredging (5 miles) = 4-5 Mcy/yr

Lower Columbia River (RM 4 to 105+): Annual O&M Dredging (100 miles) = 6-8 Mcy/yr

Jetty Construction & Inlet Evolution

1839 - 1950

and

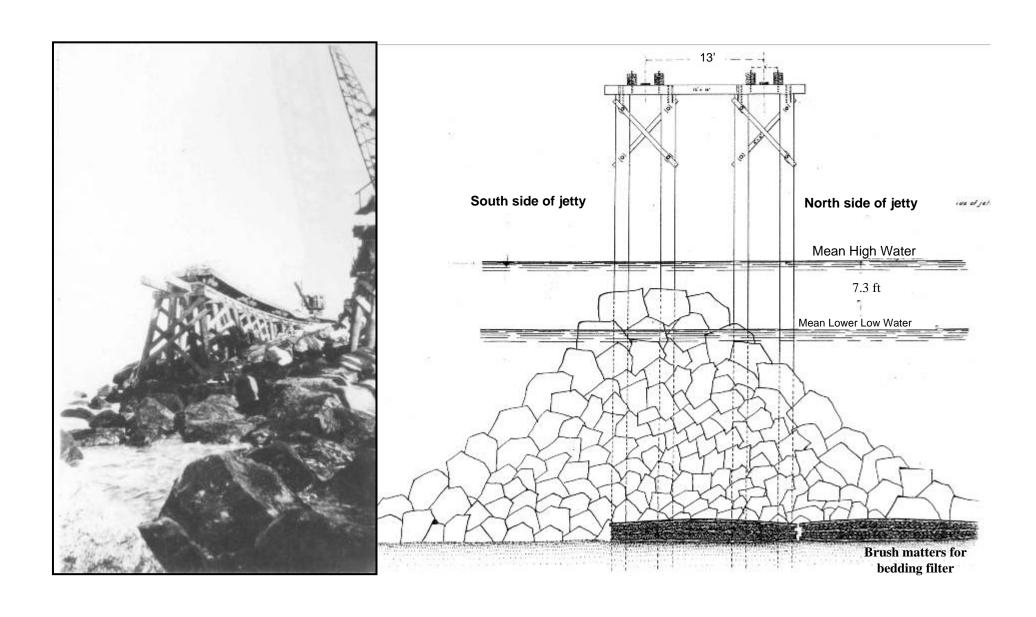
Present



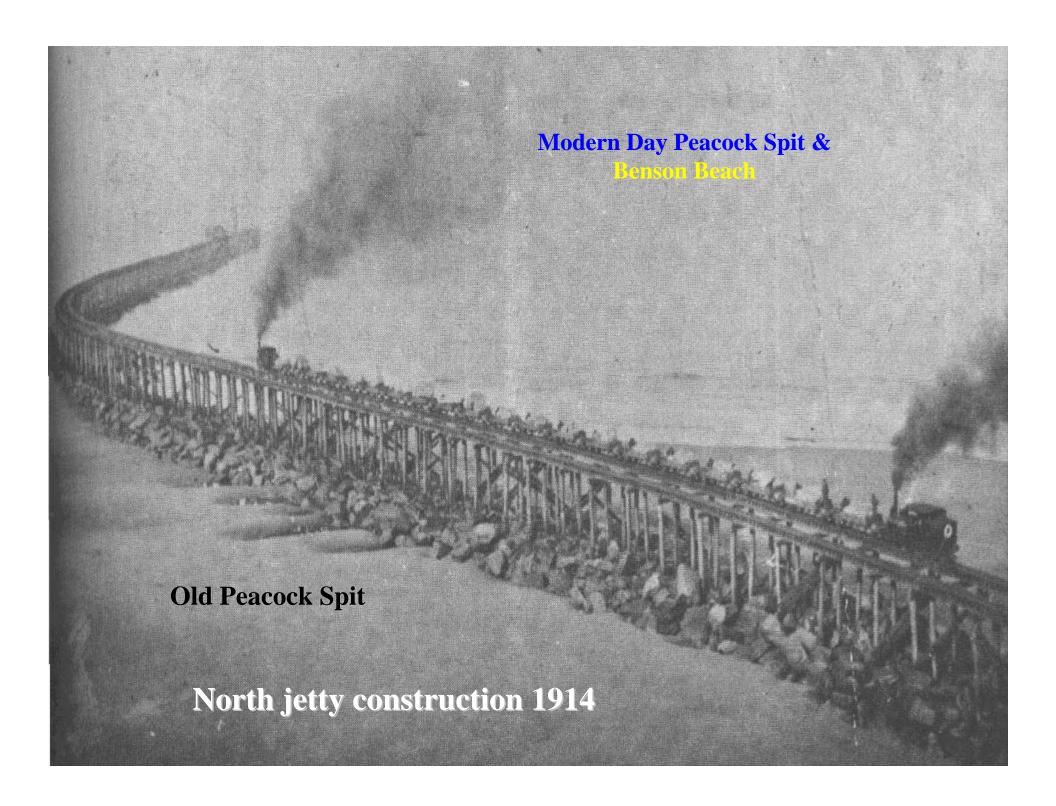
Lead Engineer, MCR Jetty Design - 1903

"The jetty is a long, thin, narrow backbone of solid material, resting upon a very doubtful foundation, against which the forces in action at the locality have accumulated large quantities of the shifting sands.

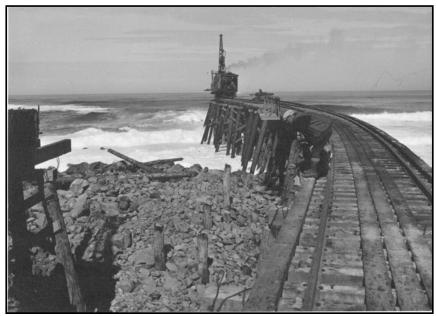
These shoals in turn have been able to break the force of the waves and protect the jetty from destruction. Jetty integrity and the permanence of the present favorable condition of channel over the bar depend upon the amount of this sand that can be accumulated."

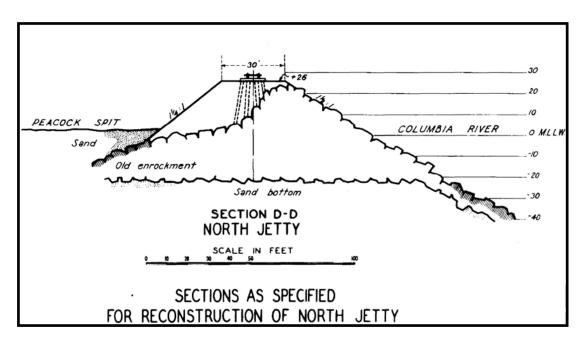


Design Section for original Jetty Construction: North/South

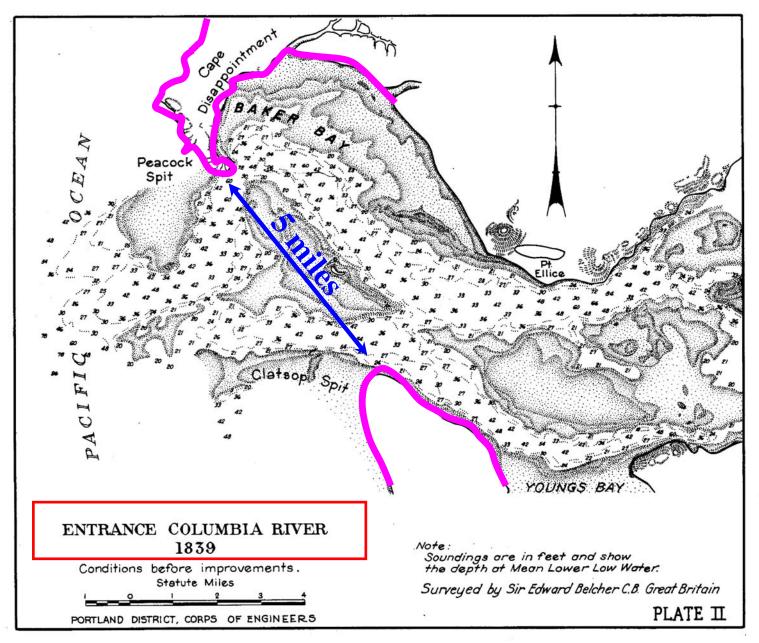


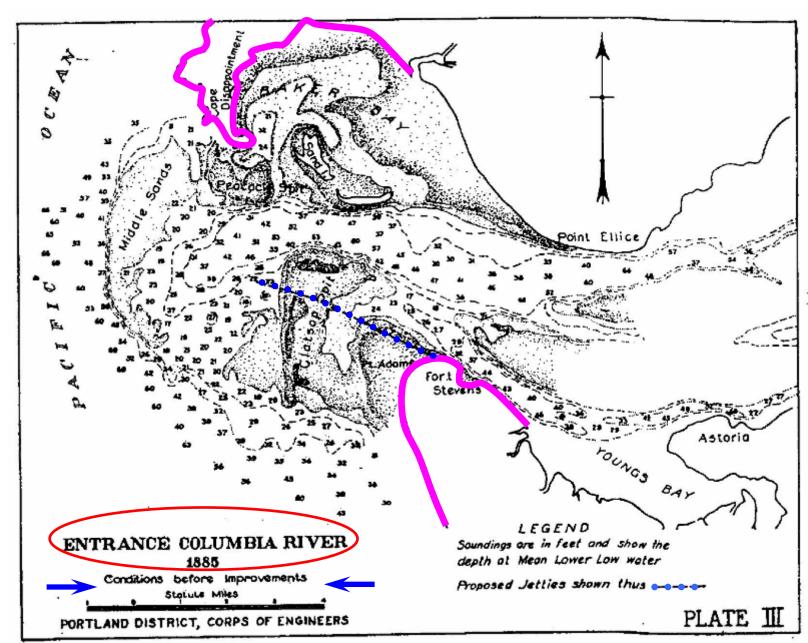




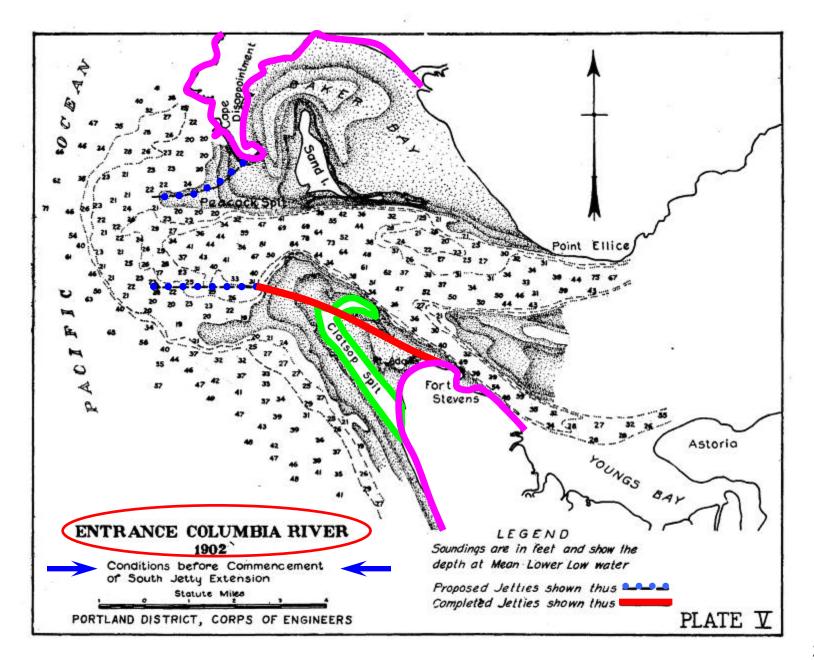


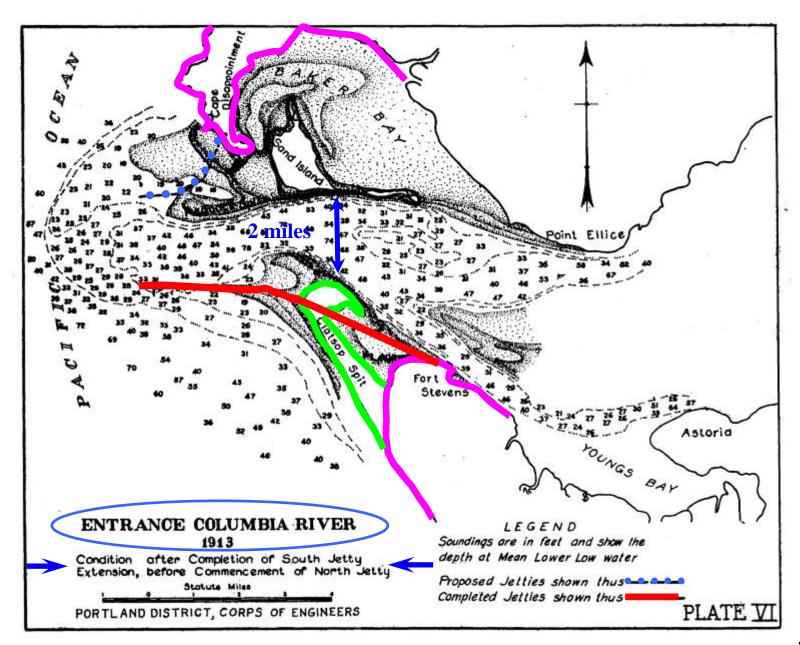


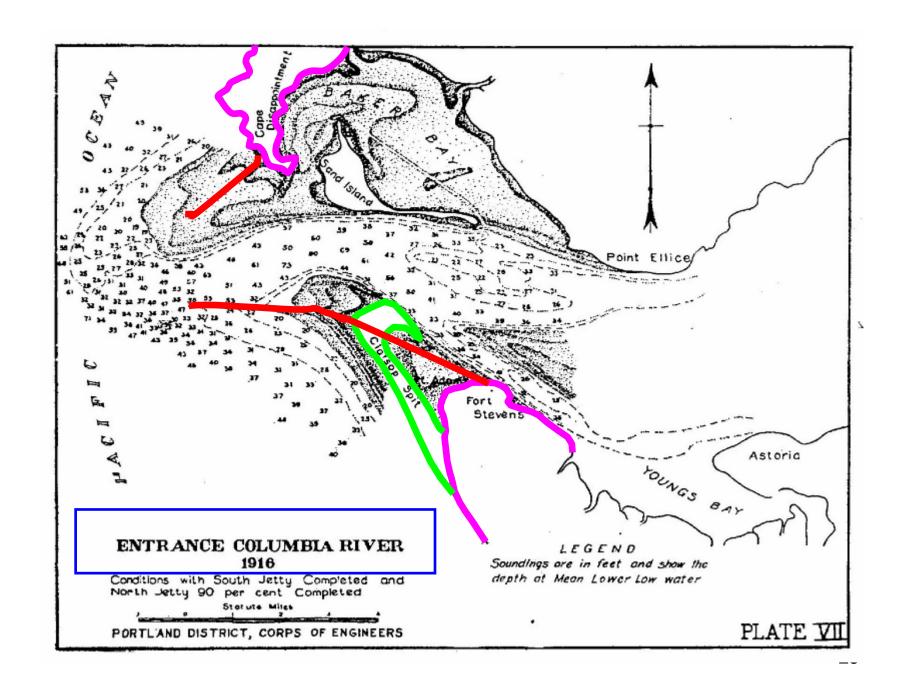


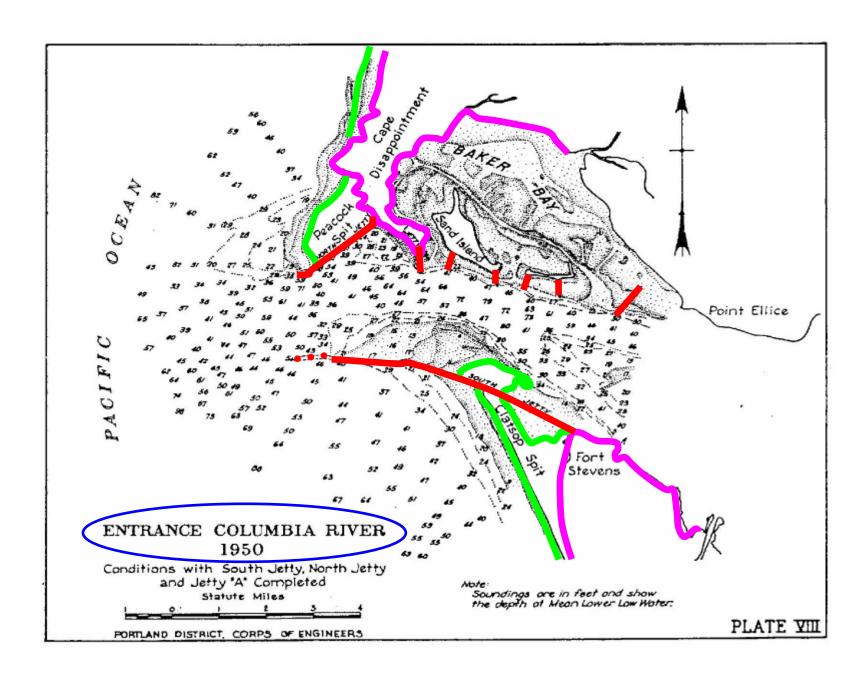


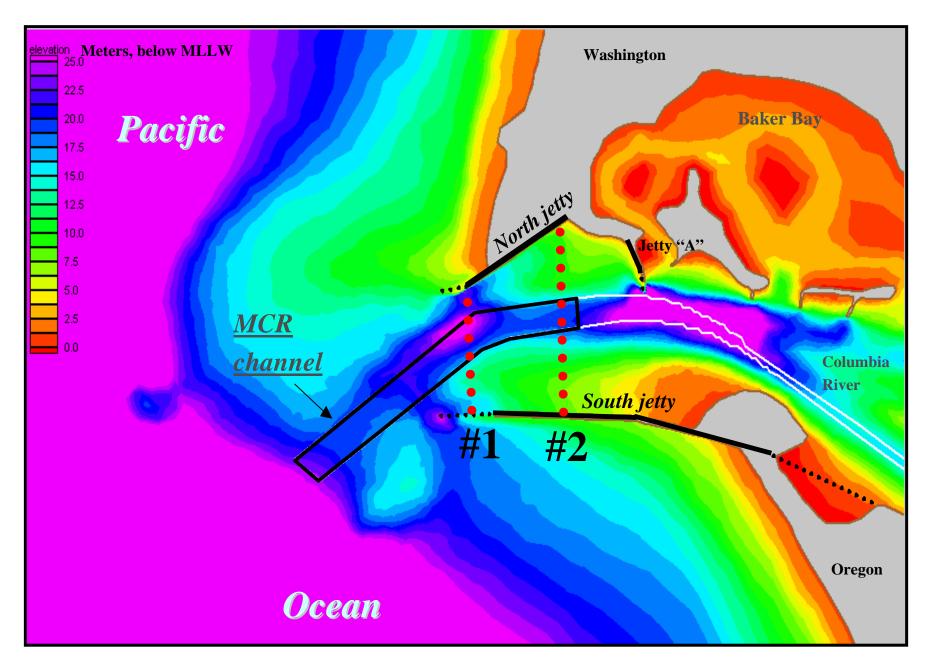
22







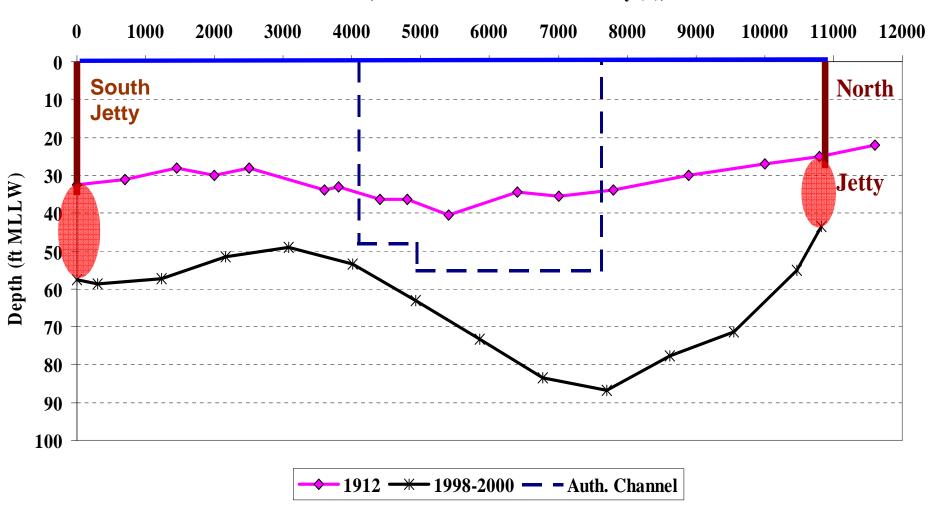




MCR Channel X-Sections – showing changes thru time

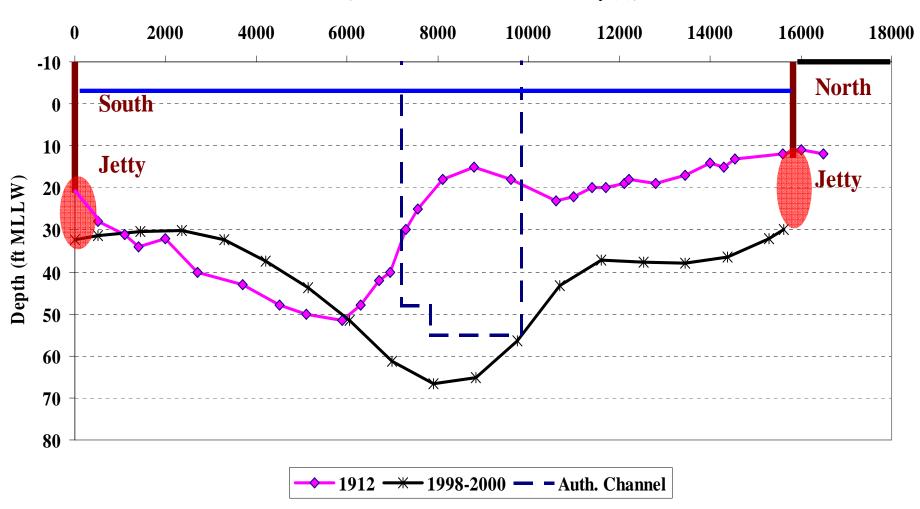
Section #1 – Showing Inlet Deepening over Time and Scour Effects on Jetties

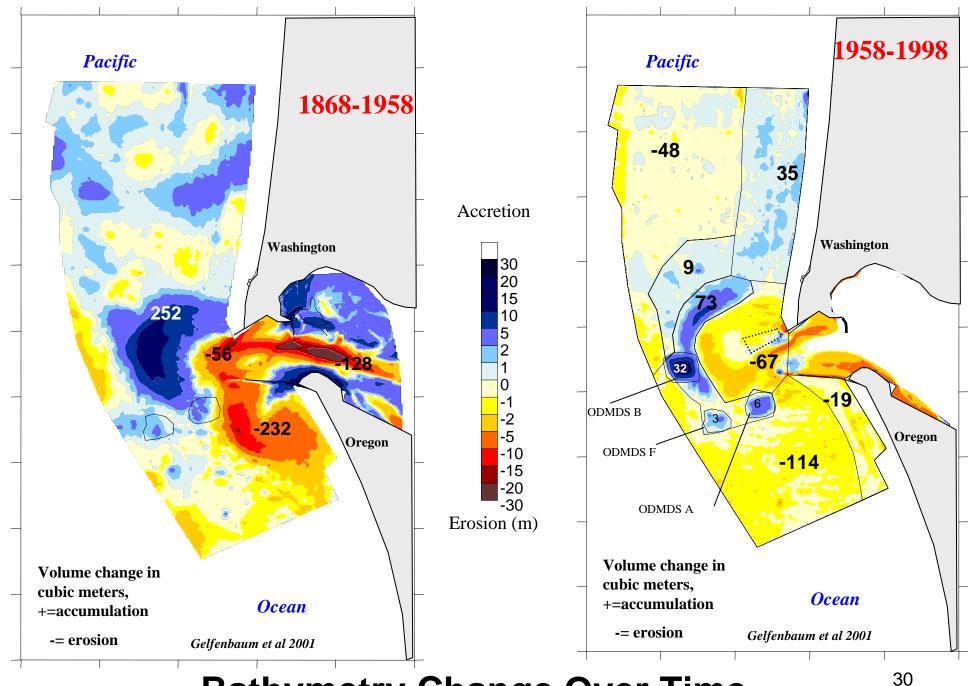
MCR Channel X-Section, Distance North from South Jetty (ft), view toward ocean



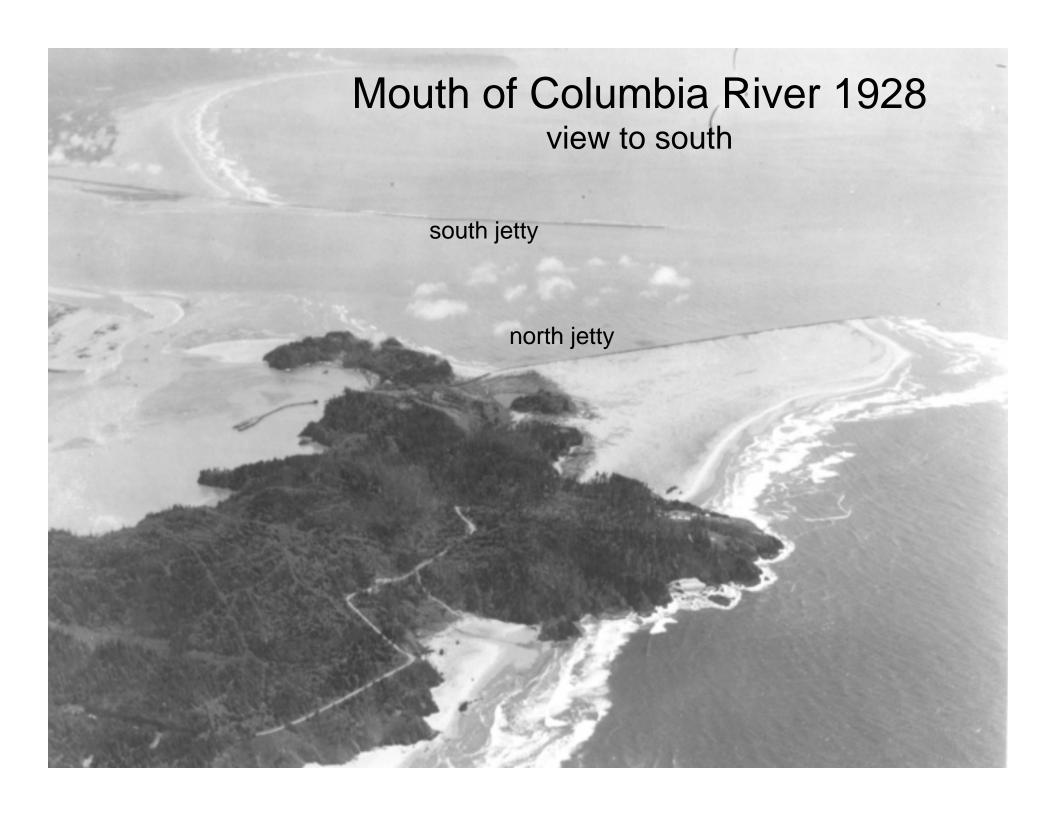
Section #2 – Showing Inlet Deepening over Time and Scour Effects on Jetties

MCR Channel X-Section, Distance North from South Jetty (ft), view toward ocean

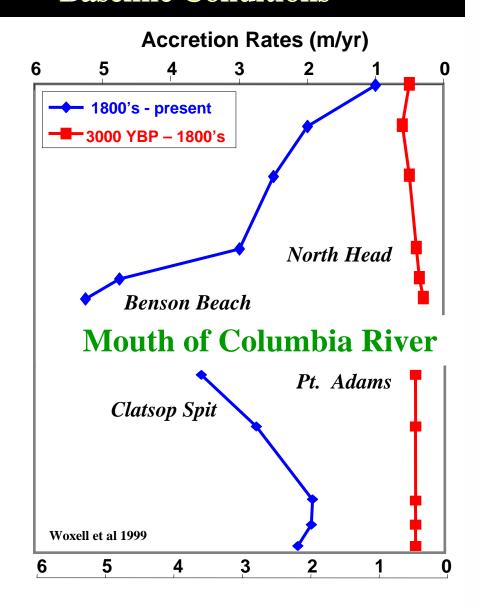


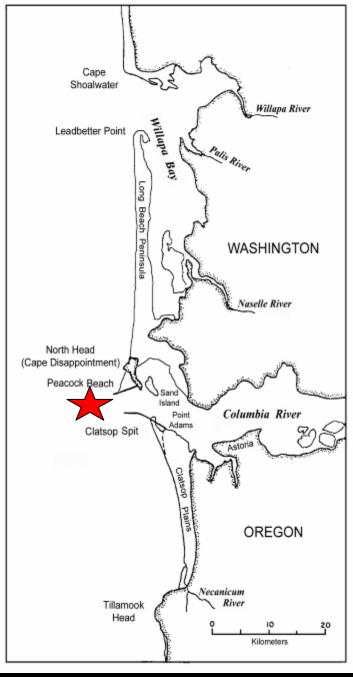


Bathymetry Change Over Time

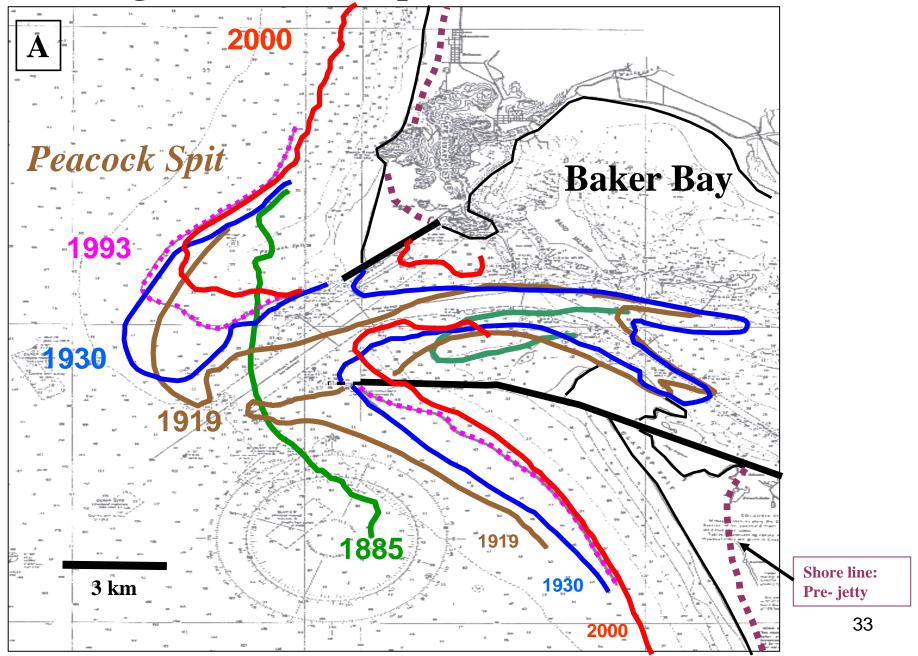


Shoreline Accretion: North vs South"Baseline Conditions"





Change in the 40-ft depth Contour thru Time



Impacts of Shoal Evolution

It's NOT the Dams

MCR Jetty Investments

SOUTH Jetty: Original Construction 1886-96, 4 miles offshore from Ft

Stevens: 946,000 tons of stone

Repair and extension 1903-14, 2 more miles offshore: 4.8 million tons of stone

8 Subsequent Repairs 1931-82: 2.9 million tons of stone

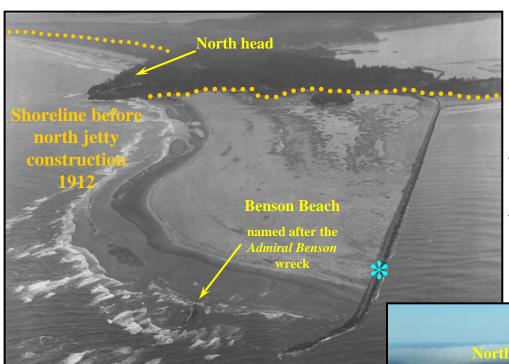
Total stone placed 1886-1982: 8.7 million tons. Total Investment = \$ 199 million

NORTH Jetty: Original Construction 1913-17, 2 miles offshore from Cape Disappointment: 2.9 million tons of stone placed

2 Subsequent Repairs 1938 and 65: 360,000 tons of stone

Total stone placed 1913-65: 3.3 million tons. Total Investment = \$881 million



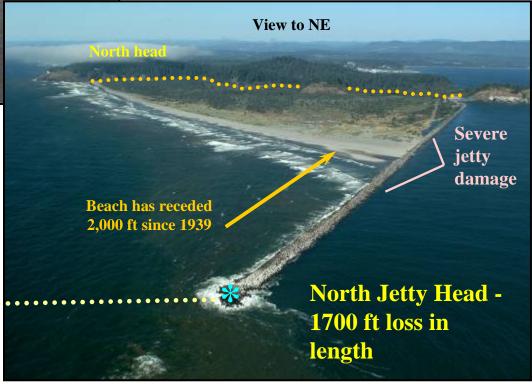


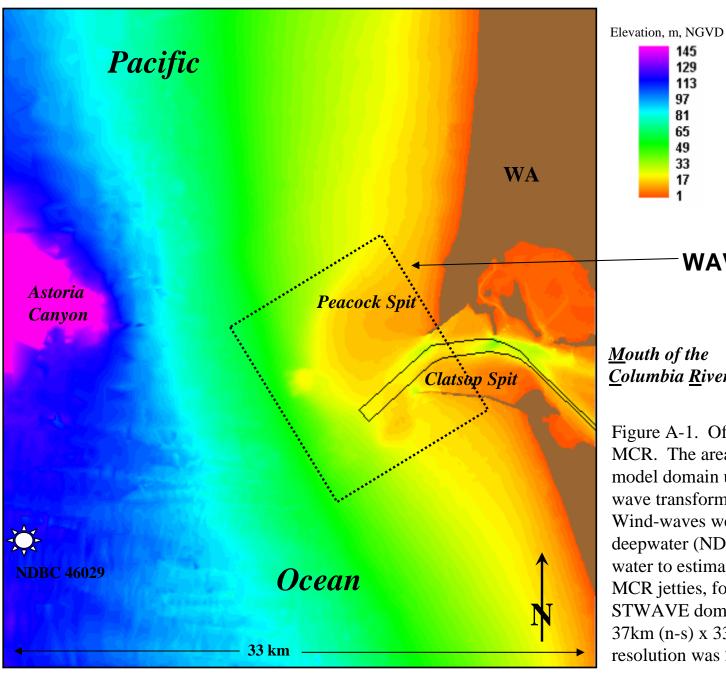
1939 MCR North Jetty

What was a "spending beach" for wave action along the ocean side of the north jetty no longer exists. Now waves and currents act directly on much of the north jetty. The north jetty is now compromised along much of its length.

2002







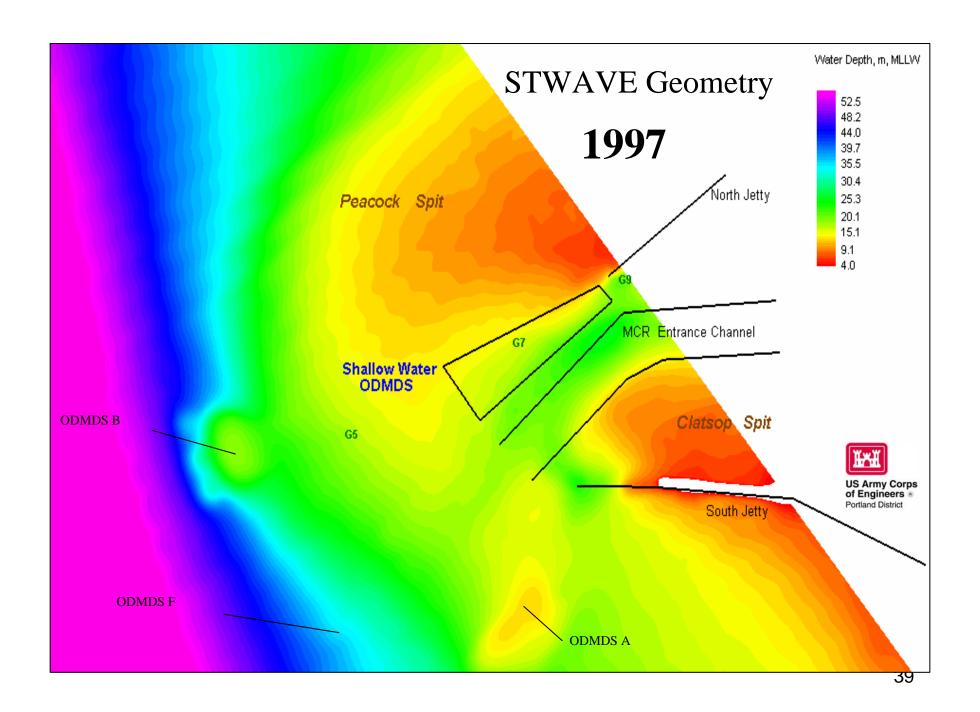
WAVE MODEL AREA

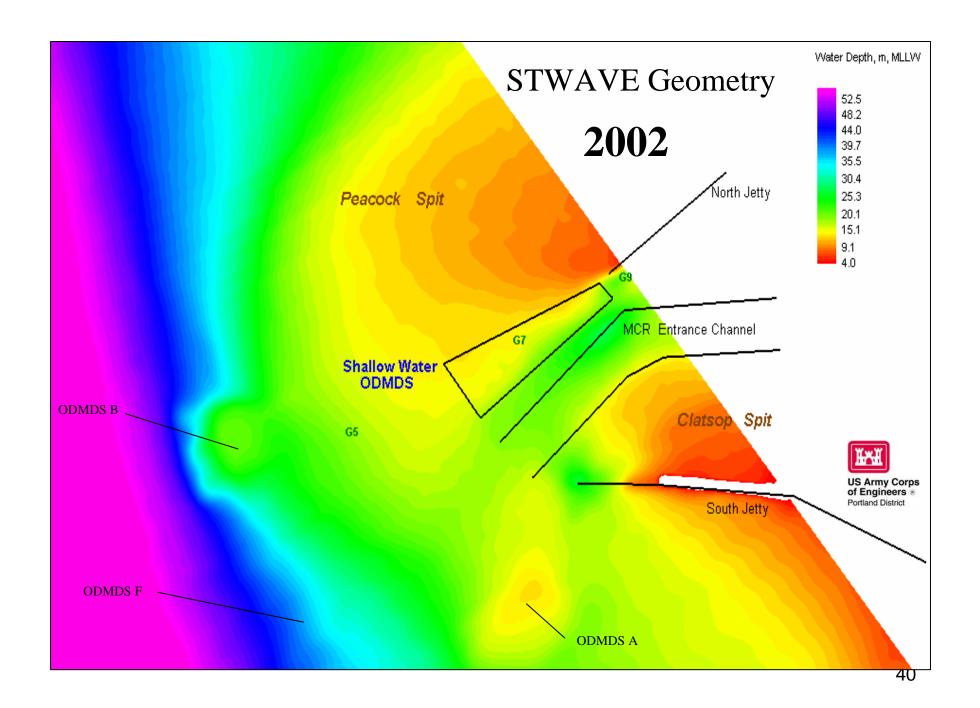
Mouth of the Columbia River

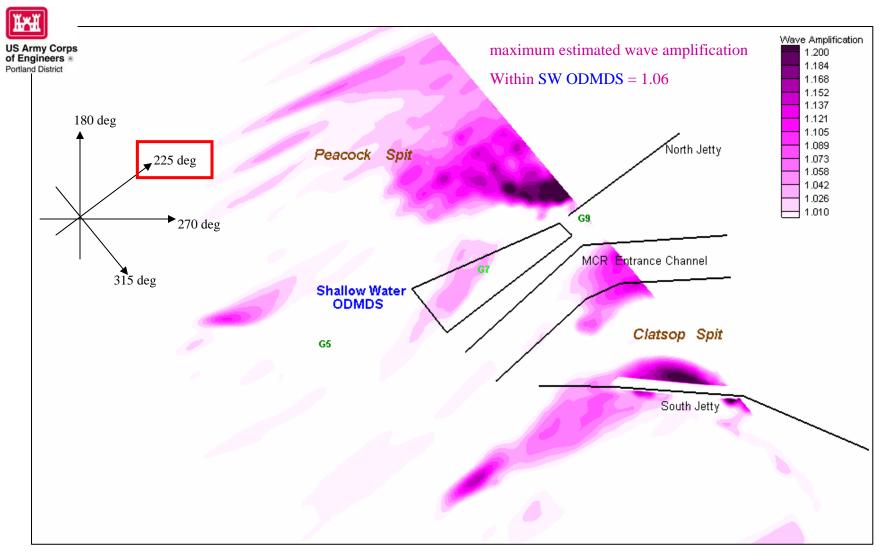
145

17

Figure A-1. Offshore bathymetry at MCR. The area shown defines the model domain used to simulate windwave transformation using STWAVE. Wind-waves were transformed from deepwater (NDCB buoy) to shallow water to estimate wave height at the MCR jetties, for 11 storm events. The STWAVE domain covers an area of 37km (n-s) x 33 km (e-w), model resolution was 20 m. 38

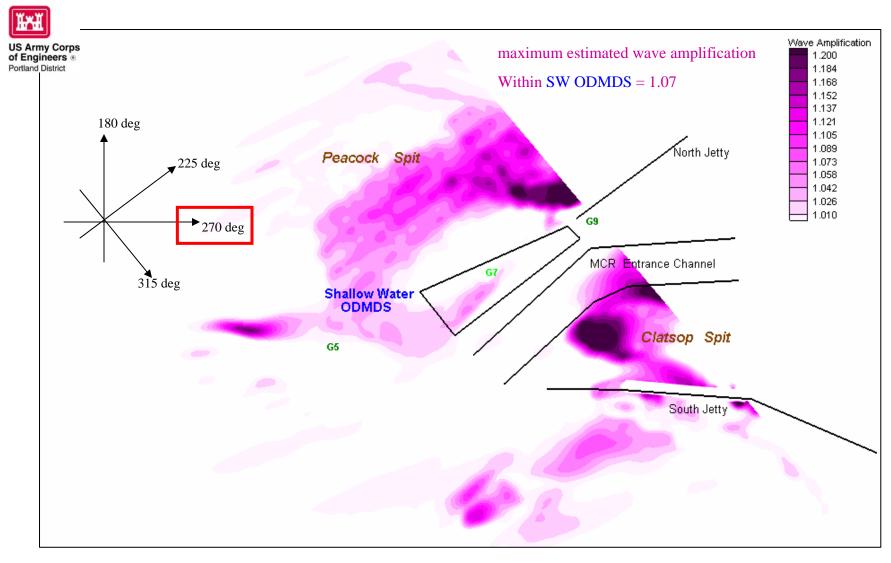






Offshore wave: Ht= 6.48 m, Tp=12.5 sec, Dir =225 deg

STWAVE Model Results: Waves in 1997 vs. 2002 41



Offshore wave: Ht = 8.34 m, Tp=16.7 sec, Dir = 260 deg

STWAVE Model Results: Waves in 1997 vs. 2002 42

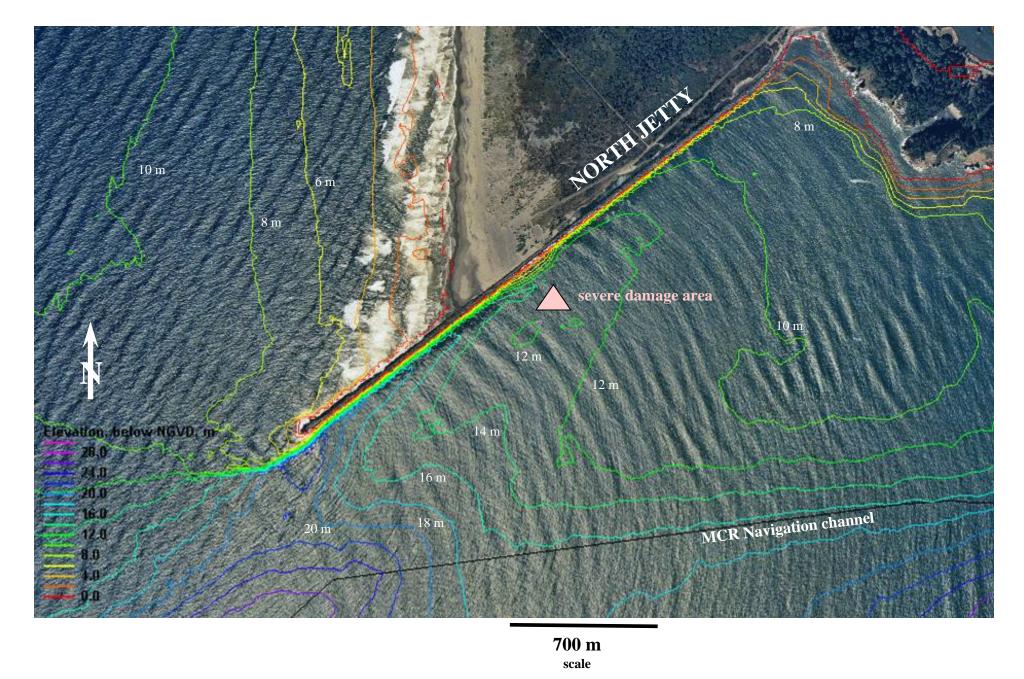


Figure 2 . North Side of Mouth of the Columbia River. North jetty shown with Bathymetry, elevation is in meters below NGVD43



North

Jetty

Damaged Areas
along Trunk

Damaged Areas along Root

Transition to Unrepaired Landward Half of North Jetty



Figure 4. North jetty damage areas.

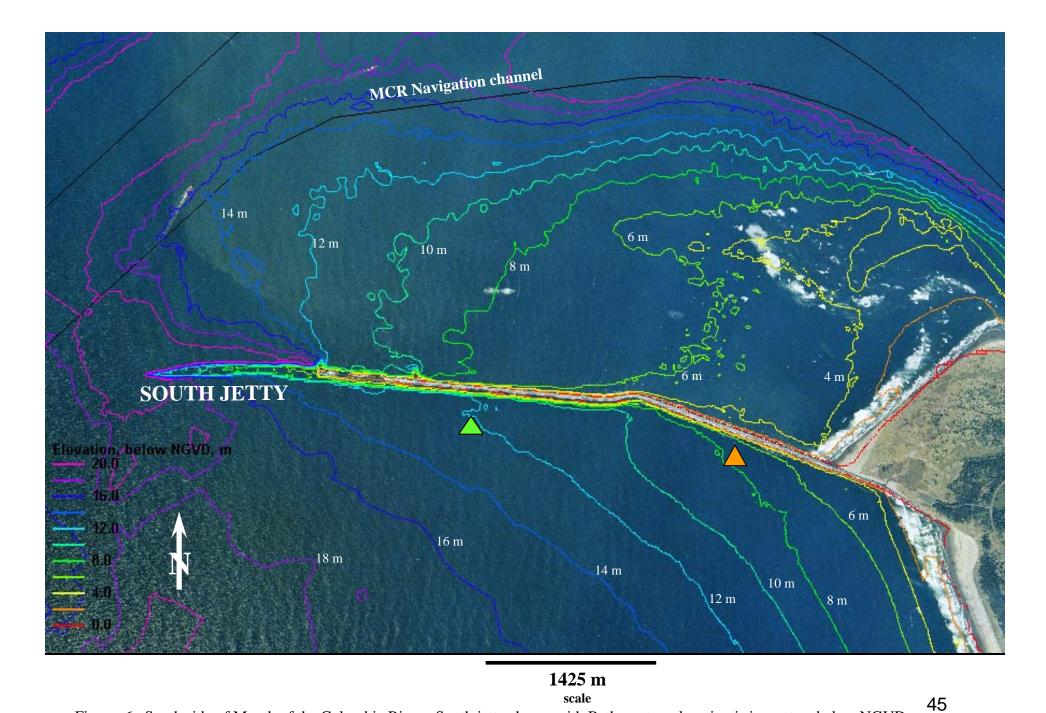


Figure 6. South side of Mouth of the Columbia River. South jetty shown with Bathymetry, elevation is in meters below NGVD.



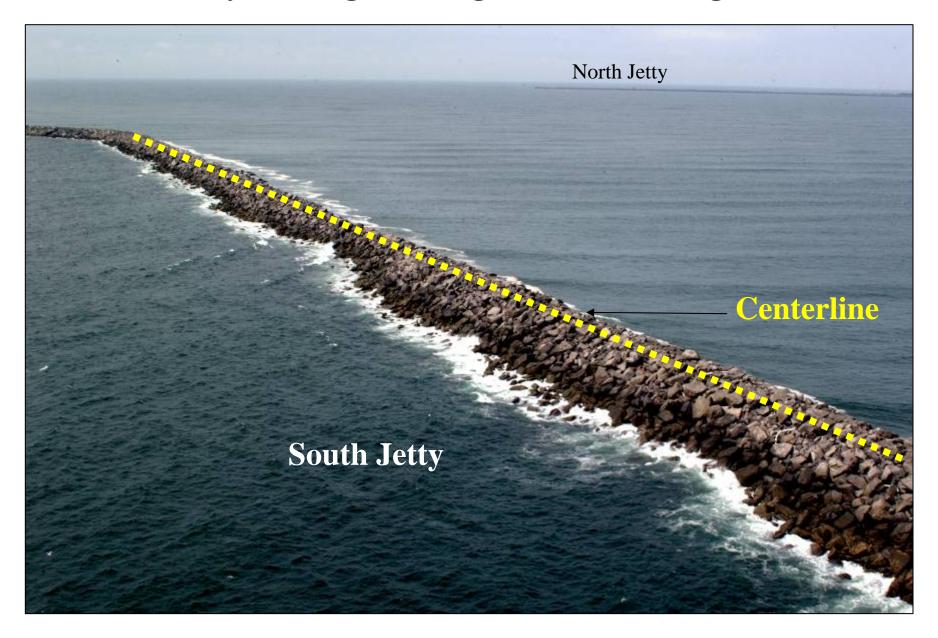




South Jetty 2002

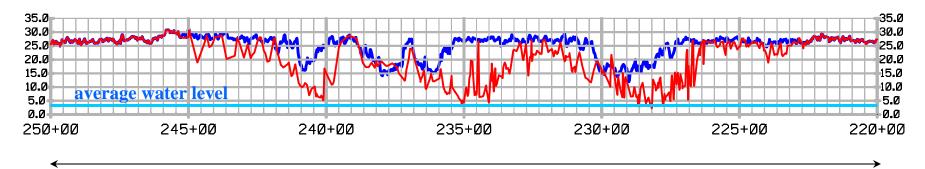


South Jetty: Changes during 1999- 2004 along Centerline



South Jetty Centerline – Changes during 1999 to 2004

1999 jetty ————— 2004 jetty ————



3,000 ft along centerline of south jetty

Present ocean extent of south jetty is 12,000 ft



Mouth of the Columbia is a Symbiotic System of Navigation Structures and Morphology

Submerged Sand Shoals are the foundation for 100-yr old jetties and control the circulation at the entrance

1 mile + of combined jetty head loss has impacted the sand shoals at MCR, dredging requirements, jetty stability, and shore erosion

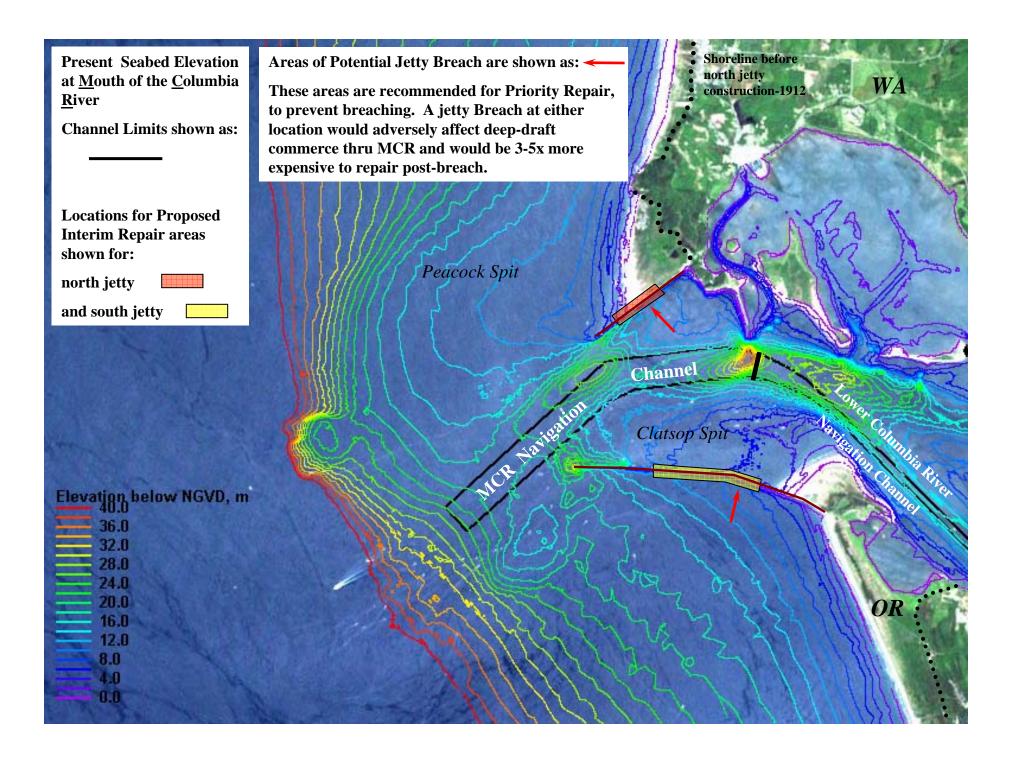
Improved Management of Dredged Material (placement) can Stabilize Sand Shoal Erosion, defer expensive jetty repair, feed the littoral system, and optimize Channel Maintenance program.

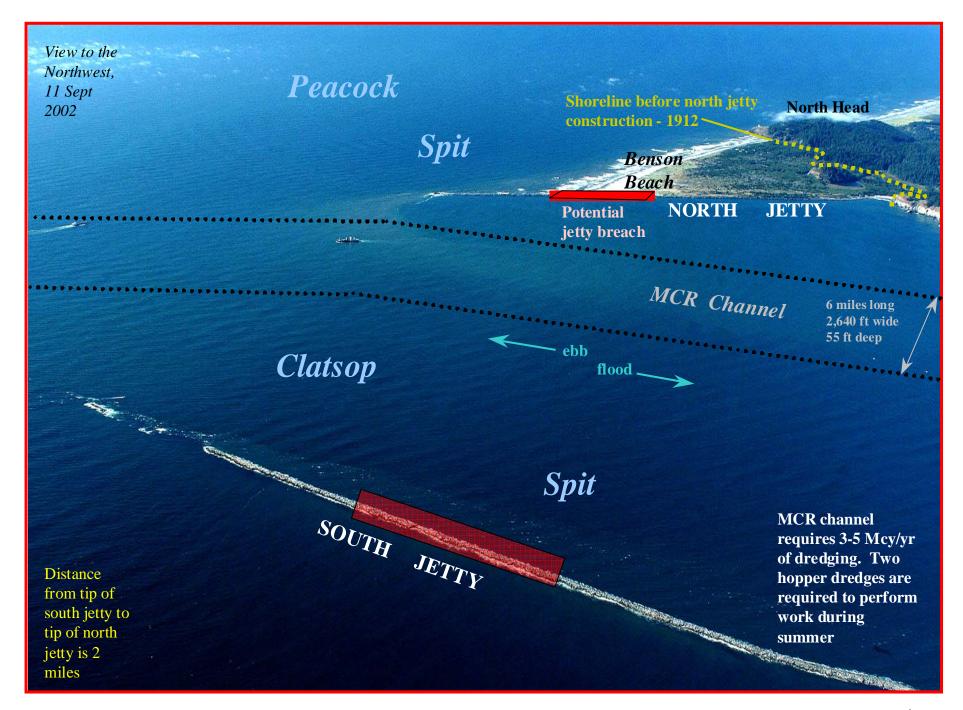
Present Jetty Repair Activities

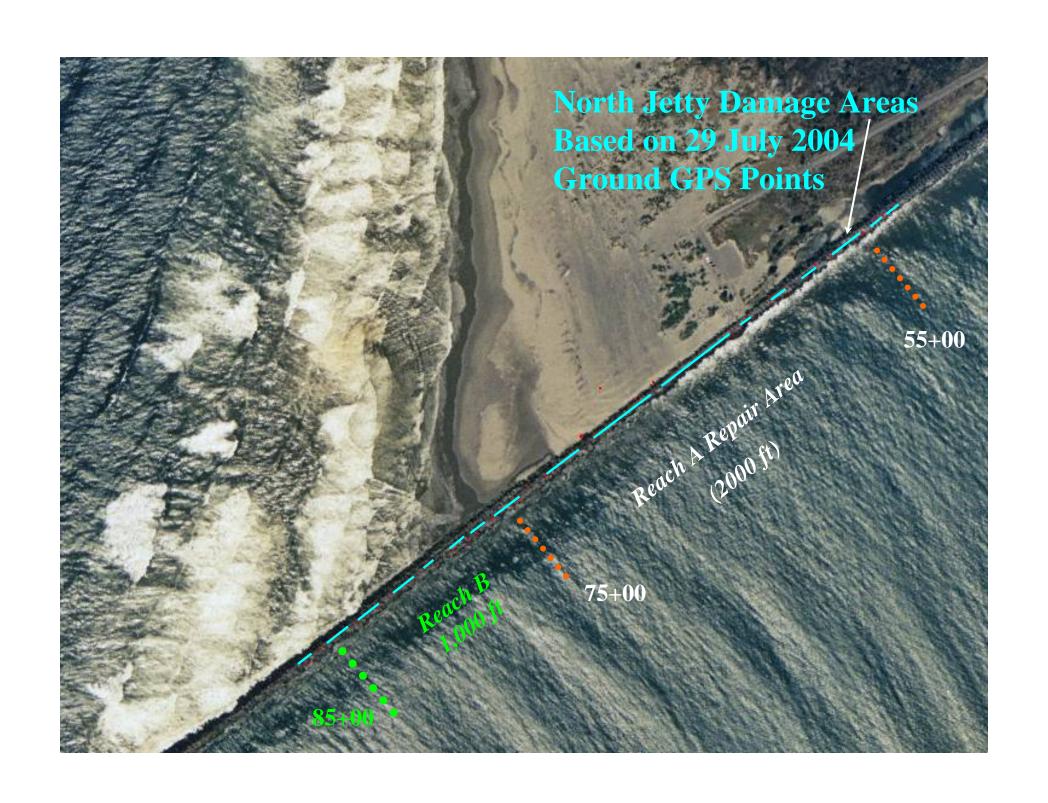
Interim Jetty Repair

Crisis Intervention

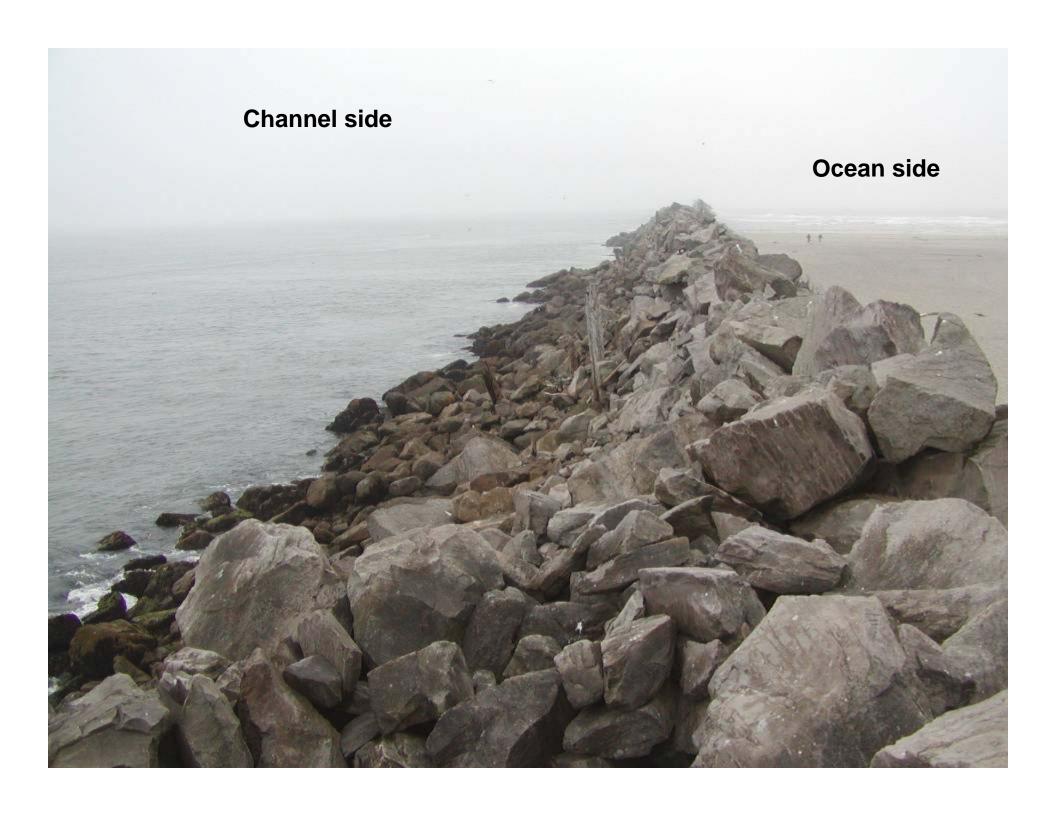


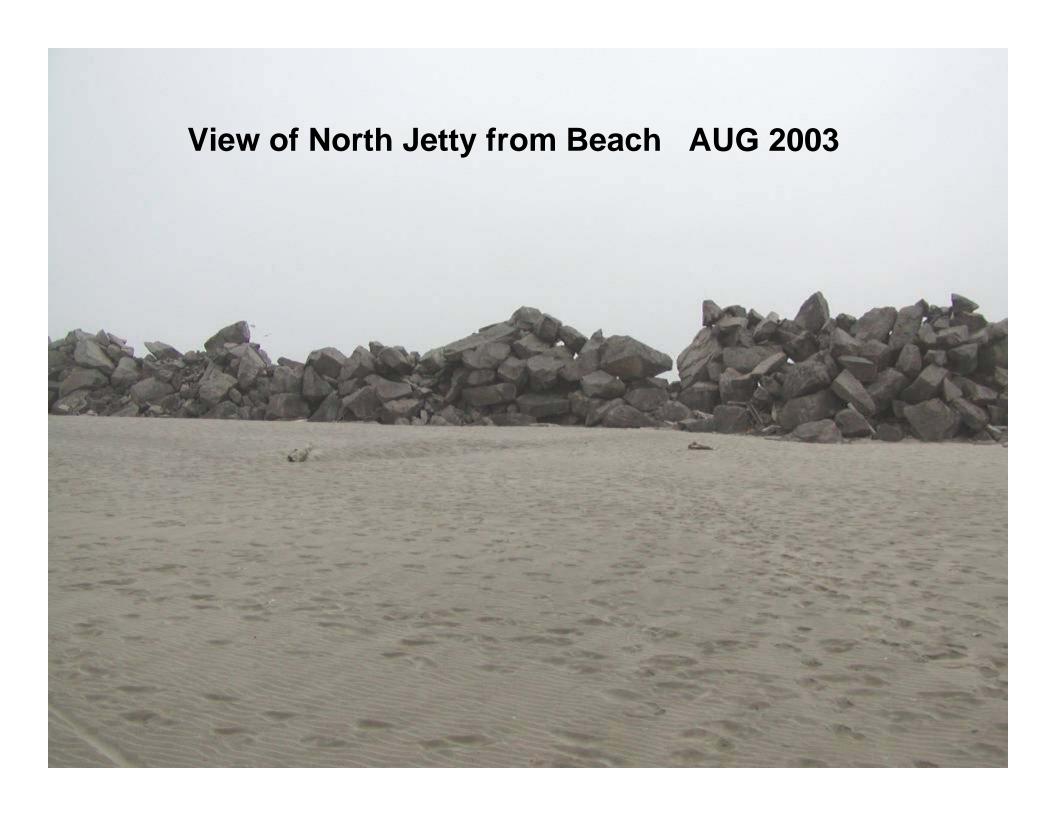


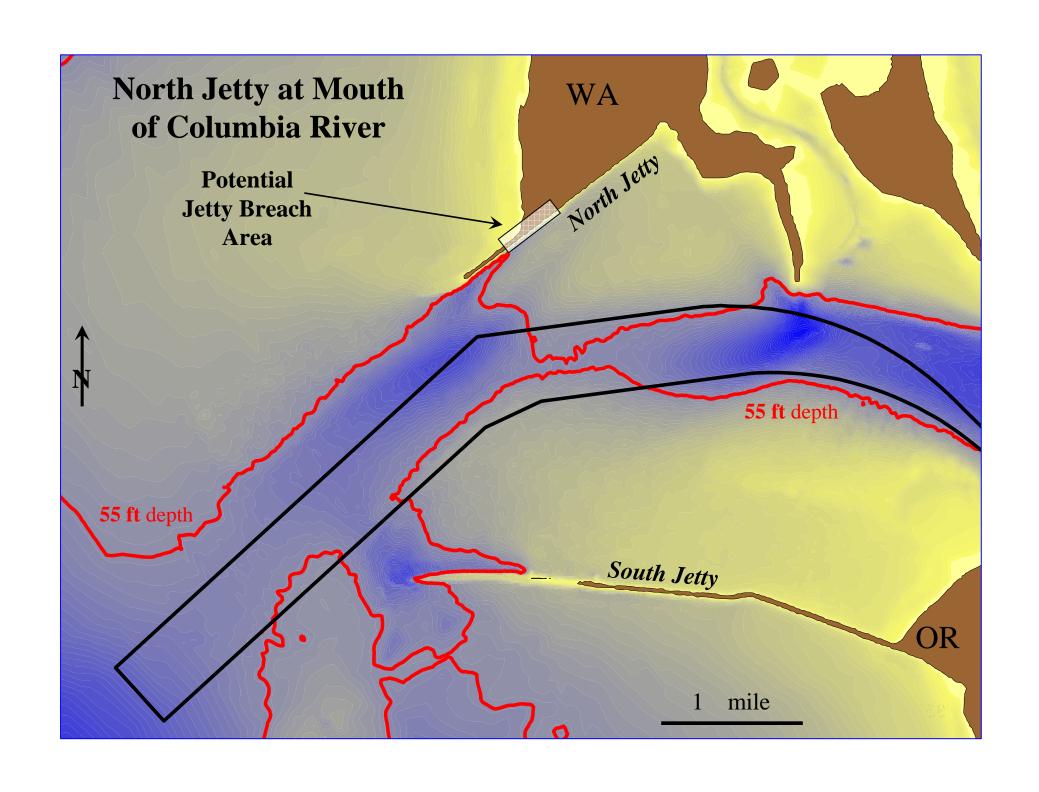


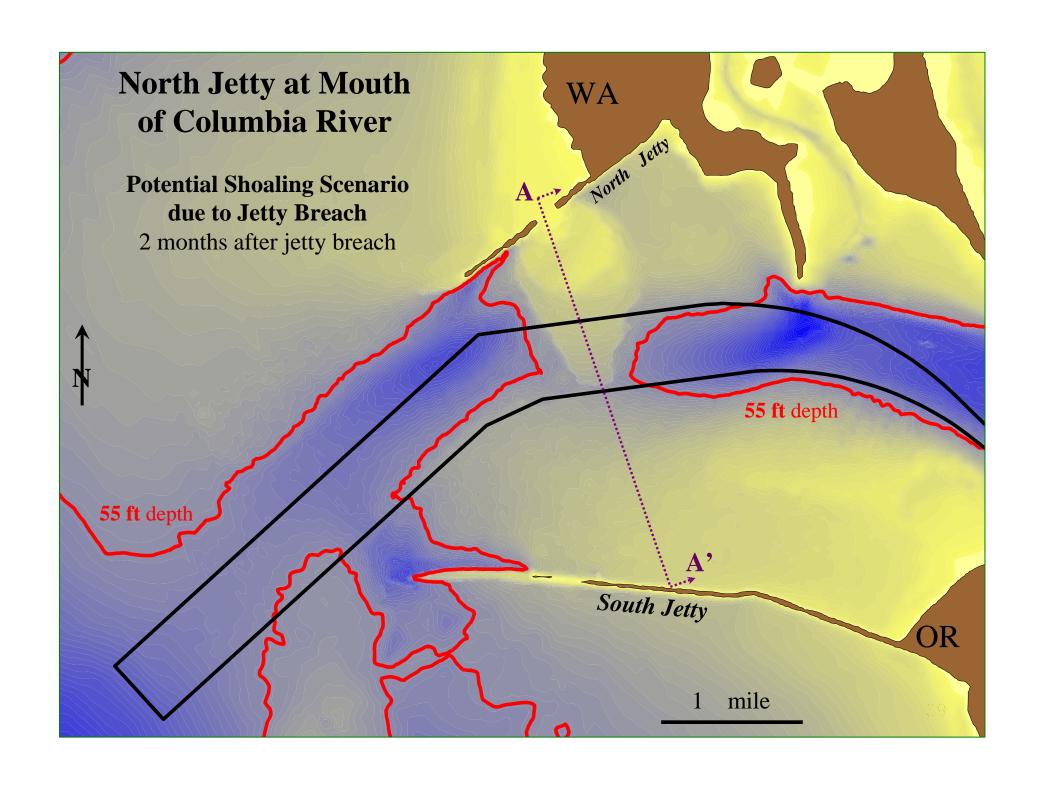




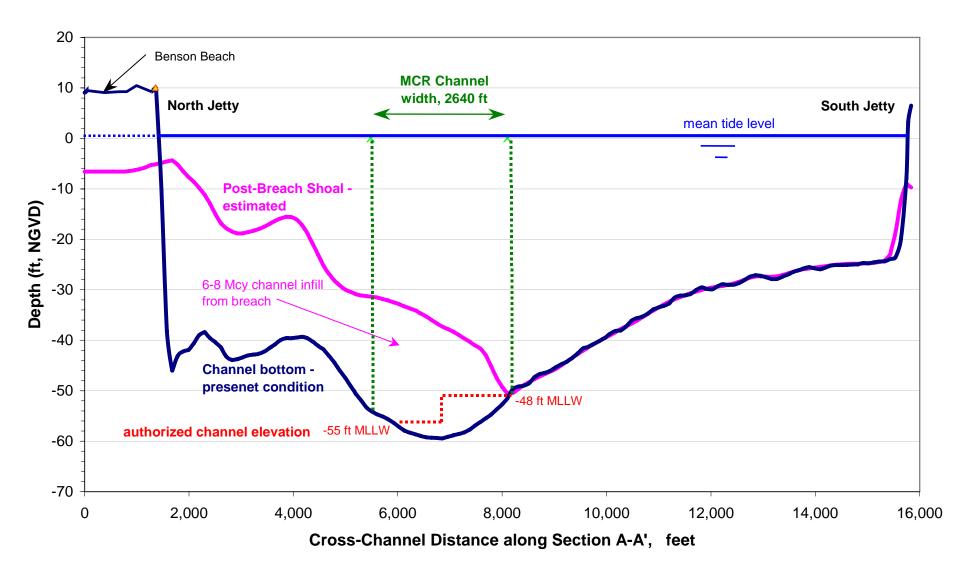


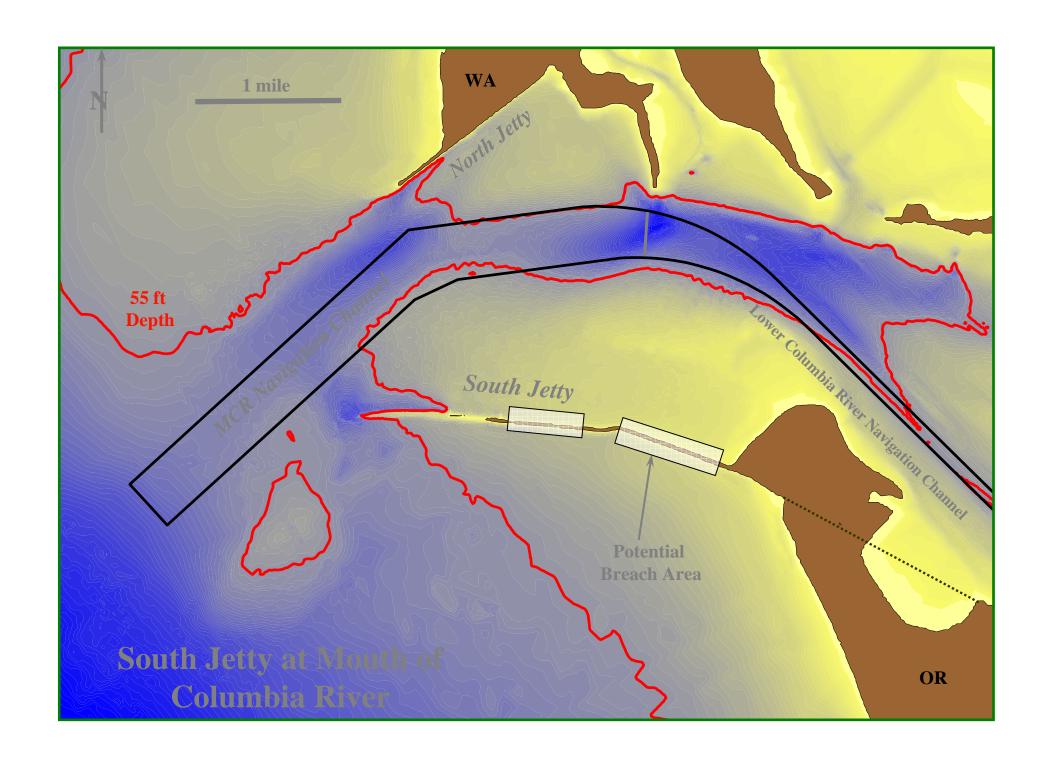


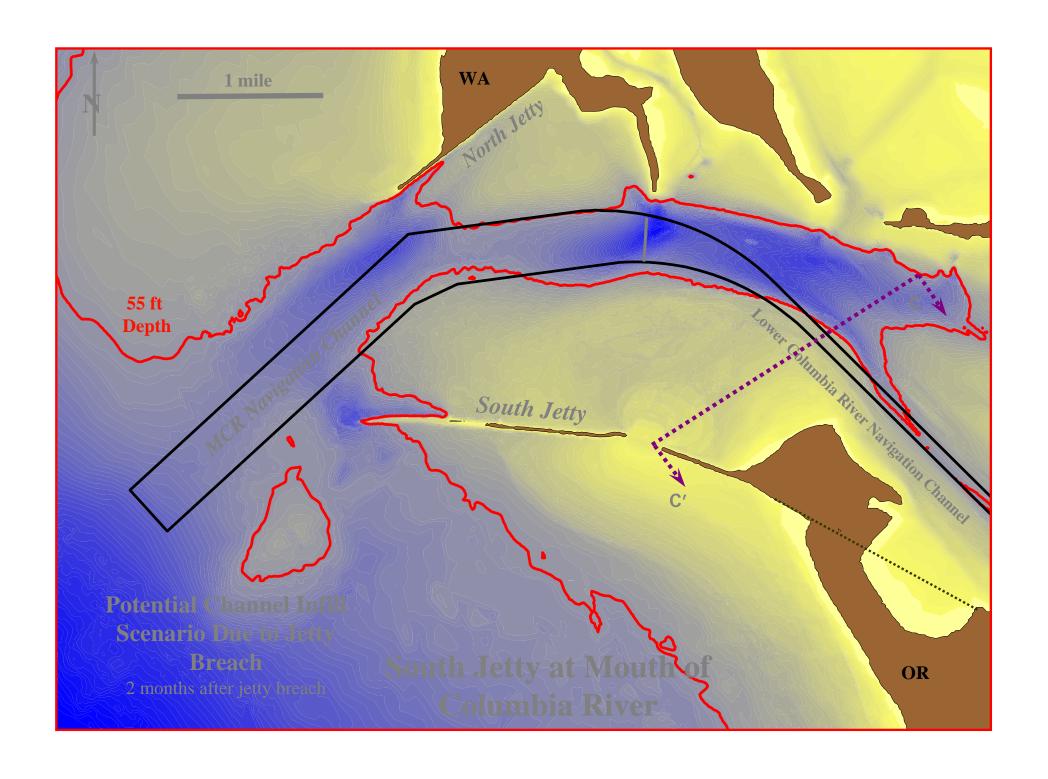




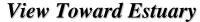
Potential North Jetty Breach - Shoaling Scenario at Columbia River Mouth

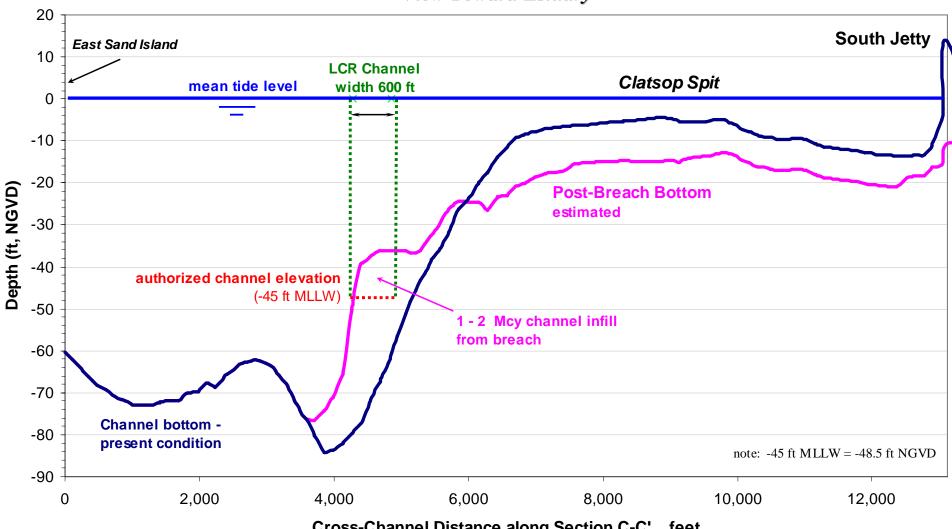






South Jetty Breach - Shoaling Scenario at Columbia River Mouth

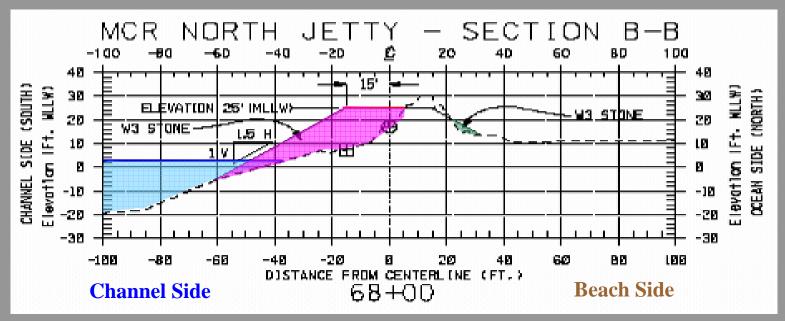


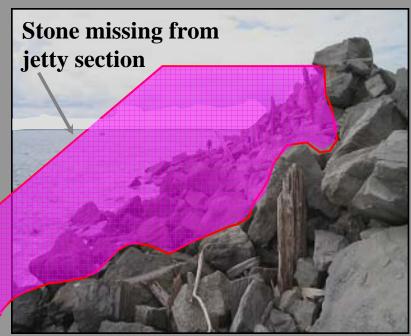






North Jetty - Interim Repairs























<u>Regional Sediment Management</u>

RSM is a *systems-based approach* for managing projects involving sediment.

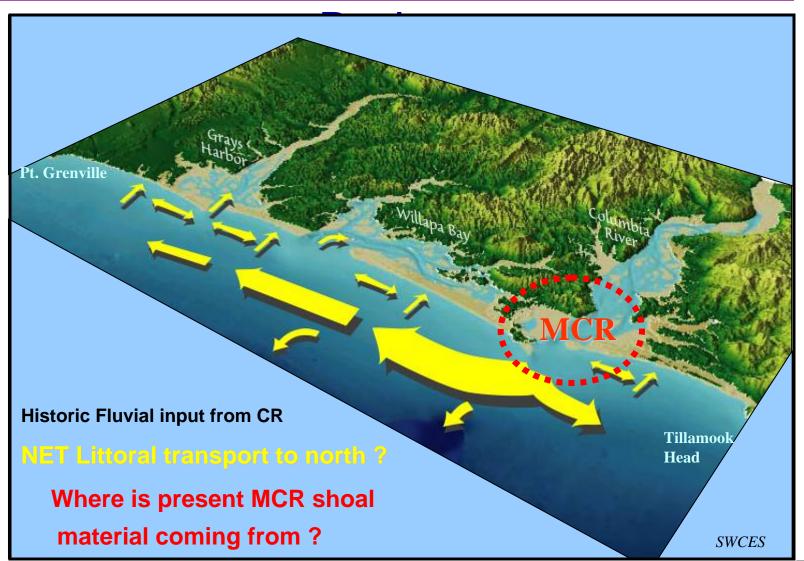
Sediment is viewed as a natural resource

RSM fosters balance between projects and natural system processes: Resulting in reduced project costs and achievement of greater benefits.

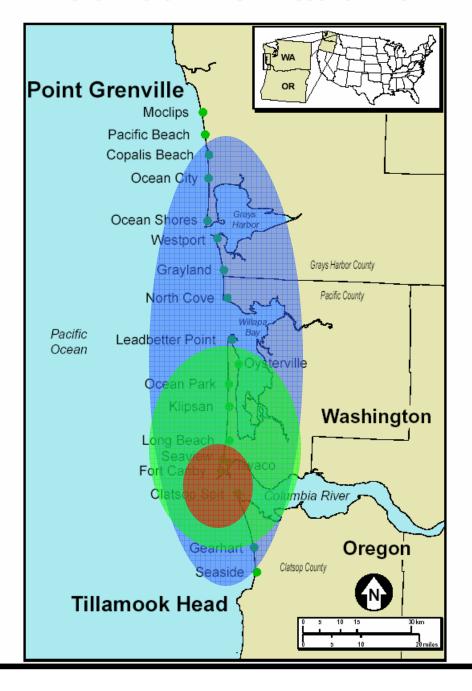
RSM broadens the "planning horizon" for projects by considering the extended time-space scale as defined by natural sediment processes.

RSM requires full *collaboration* among agencies, levels of government, and stakeholders.

Present Concept for Sediment



Columbia River Littoral Cell



Demonstration
Project Requires
Us to Focus on a
Priority Area as
First Step-MCR

Address First Order Effects First

Then Expand Outward
Thru Continued Work

Some Motivating Questions

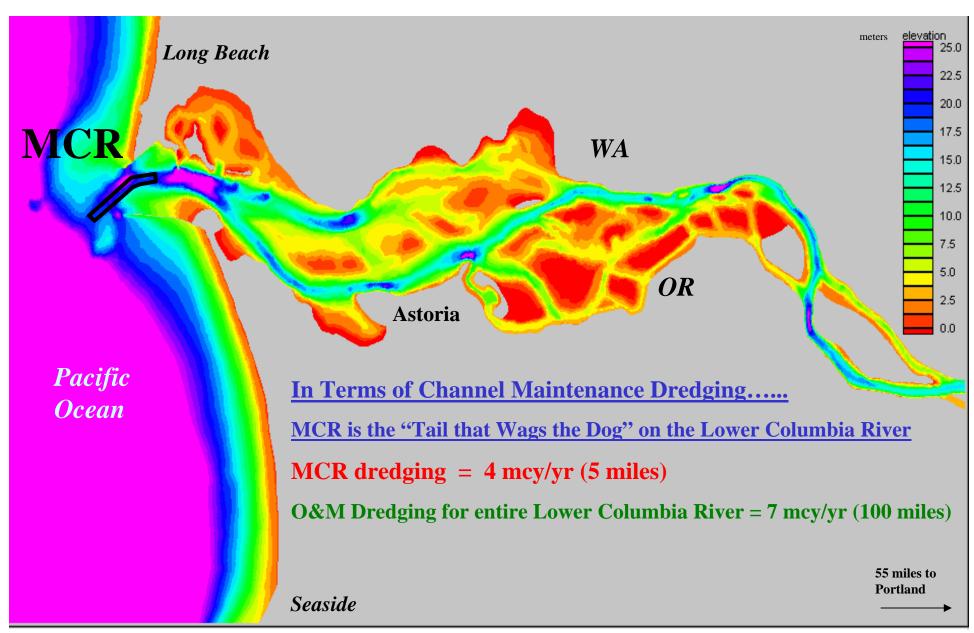
- * Are There Beneficial Locations to Place Dredged Sand?
- * What has Been the History of Sediment Movement at MCR? Does the past dictate present & future trends?
 - * What Moves the Sediment at MCR?
 - * Where does the Sediment Go-- at Present??

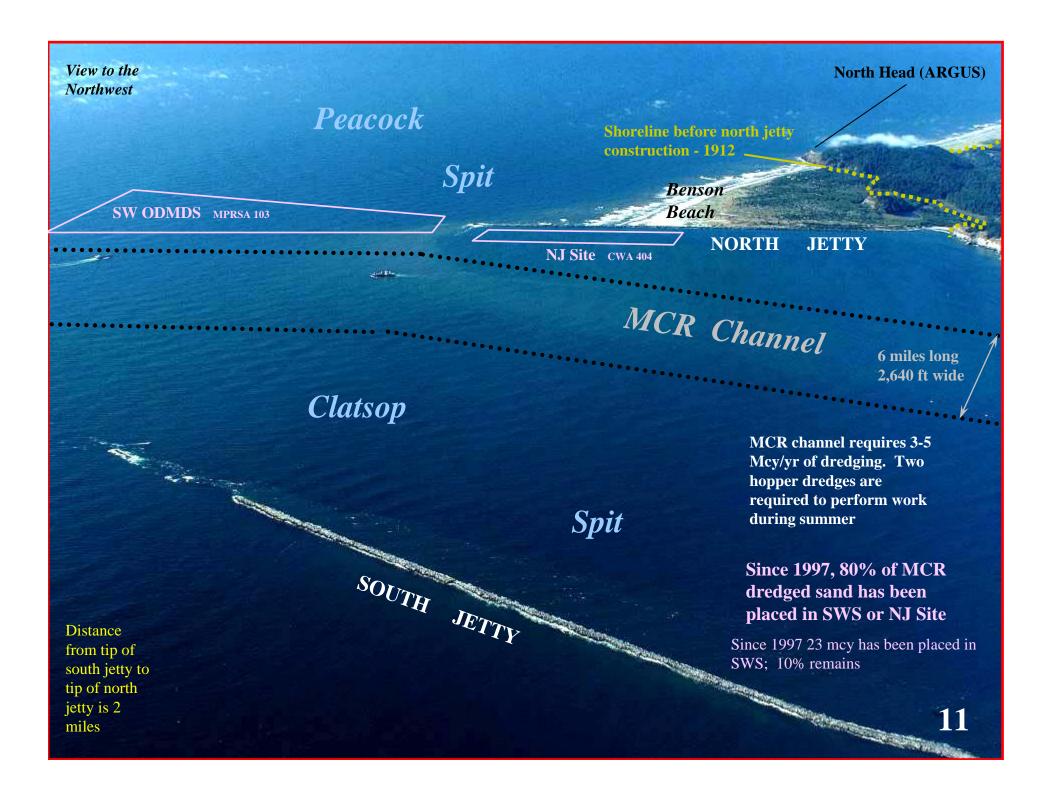
North vs. South

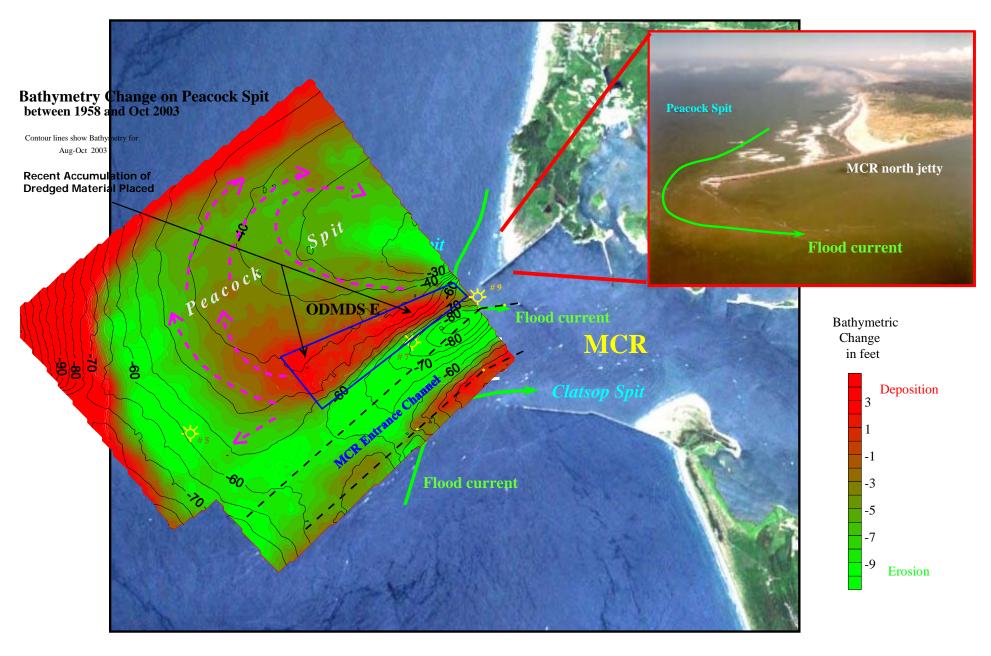
Inshore vs. Offshore

Into MCR vs. Out of MCR

* How Far Offshore Can we Place Dredged Sand and Still Have Positive Impact on Nearshore Zone?



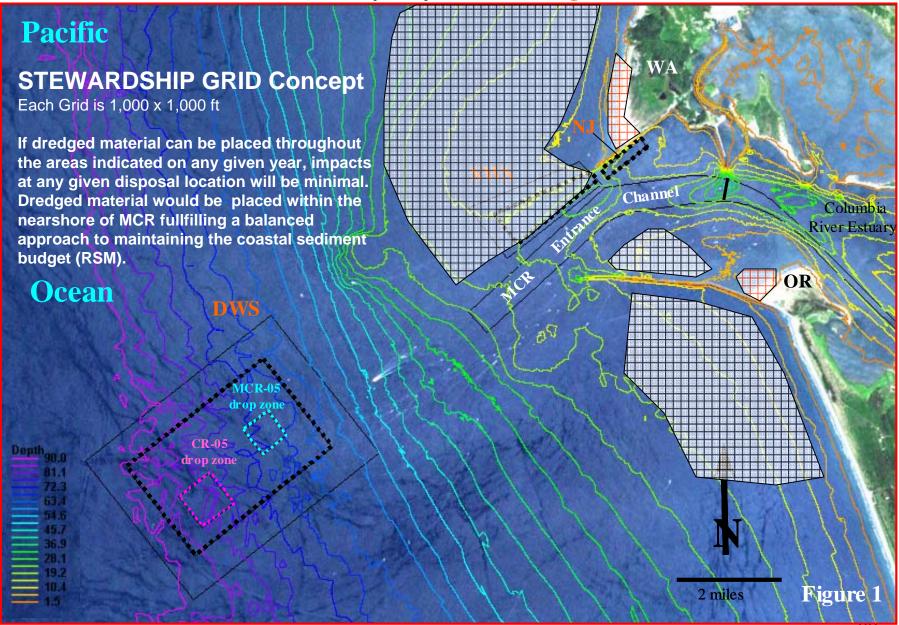




1973-1997: 50 M cy of dredged sand placed in ODMDS E (SWS)

1997-2005: 23 Mcy has been placed 3 Mcy remain within SWS

Mouth of the Columbia River - Bathymetry and 2005 Dredged Material Placement Sites



DWS= Deep Water Site, 102 MPRSA NJ Site = North Jetty disposal site, 404 CWA SWS= Shallow Water Site, 102 MPRSA (formally Site E, 103 MPRSA)

RSM Demo at MCR

A Collaborative Approach to Improving the Sustainability of MCR

Learning by "DOING"

A sampling of two (of many) Initiatives

ARGUS Beach Monitoring System at North Head

Mega-Transect Oceanographic Data Collection

Depth-Averaged Flow-Field at MCR

ADCIRC Results: For October 1-10, 1997---includes riverine flow, tides, and wind

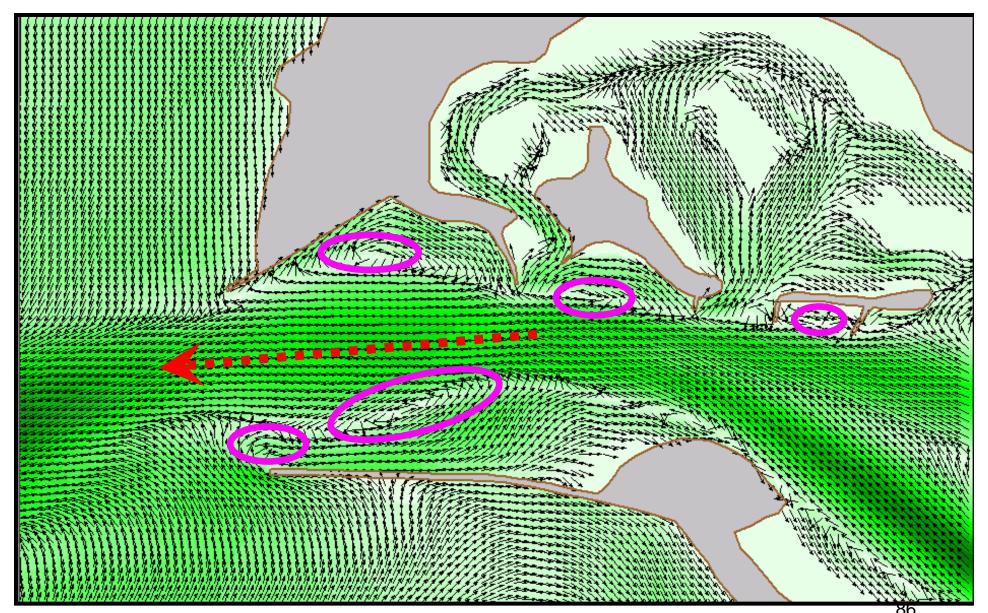
Average of Ebb – Flow

Average of Flood – Flow

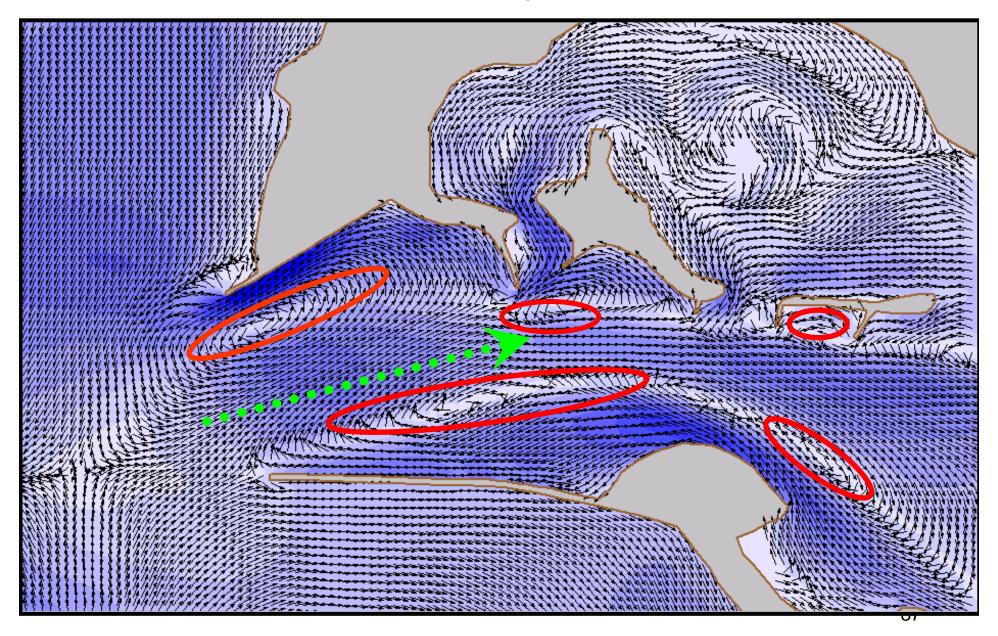
Net Average over 10 days

 Presence of Eddies and Baraclinic Flow Necessitates look at 3-D Effects

Simulated Flow Pattern During *Ebb* & *Eddies*

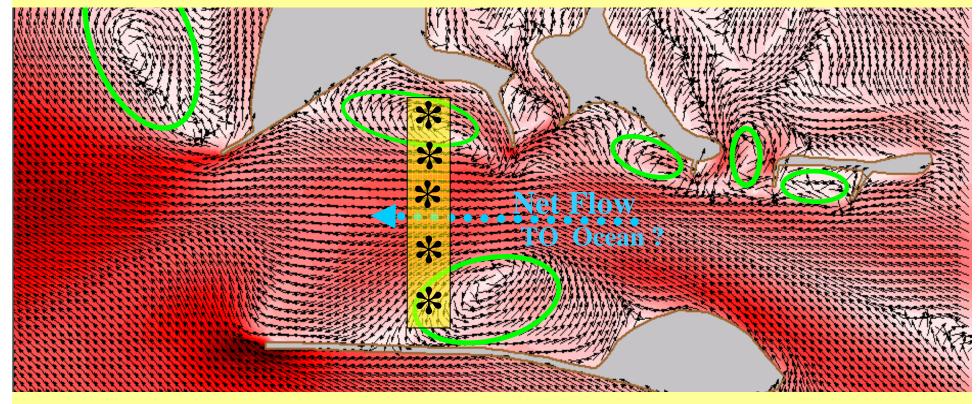


Simulated Flow Pattern During Flood & Eddies

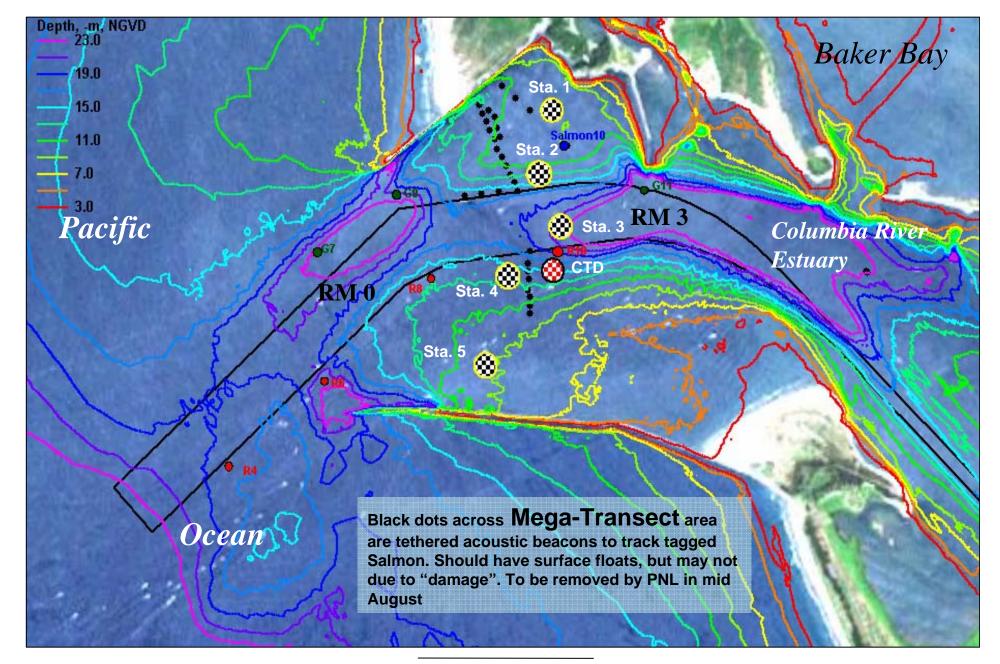


NET Simulated Flow Pattern & Eddies for 1-10 Oct 1997

PROPOSE: Conduct Simultaneous Flow & Sediment Measurements along "Mega-Transect", across MCR.



Deploy 4-8 "tripods" on bottom for 1-3 months and collect DATA



Station 1: 8 ft Tripod with ERDC Instruments [1500 kHz ADP, 20 m-Paros, OBS

(2), CT(SB-MC), ADVO] need shorter tripod in this active fishery area, cab pots and all sorts of "fishing". Offset 1,000 ft from nearest NOAA-NMFS acoustic beacon. Near surface CTD element to be placed on buoy line. Wave Burst ADVO data = 34 Min duration@2Hz every 1 hour

Station 2: 9 ft Tripod with USGS Instruments, Tripod "C" SLOPING SEABED and sand waves. Offset 1,000 ft from nearest PNL acoustic beacon. Wave Burst ADVO data = 17 Min duration@2Hz every 0.5 hour

Station 3: 8 ft Tripod with ERDC and NWP Instruments [NWP 500 kHz ADP, NWP Paros, OBS (2), CT(SB-MC), ERDC ADVO] use best cond. ERDC/NWP OBS and CT. Proposal to use 8 ft tripod in channel to maintain low profile to minimize anthrop Interference and minimize hydrodynamic loading. Shifted -21 MLLW based on Bar Pilots request. Wave Burst ADVO data = 34 Min duration@2Hz every 1 hour

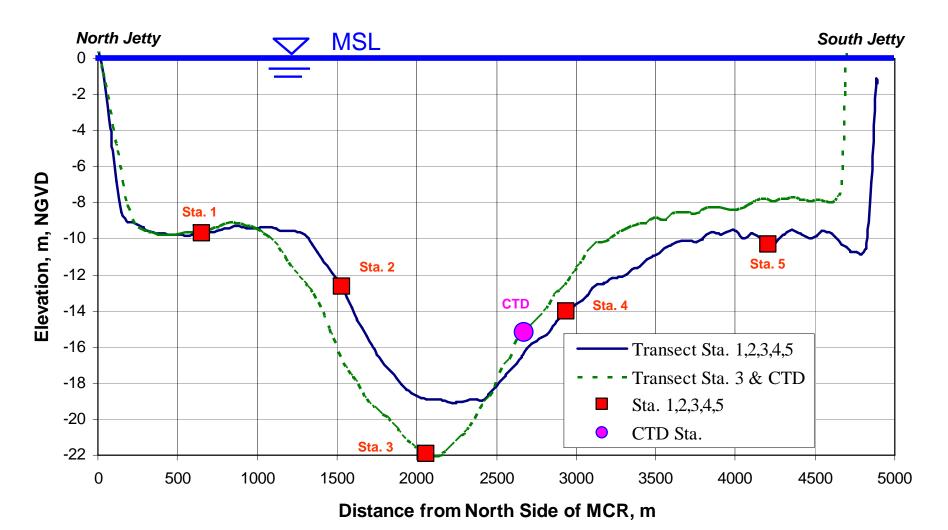
CTD Array: 6 CTD elements distributed uniformly thru deployed depth, Tether is to be "compliant" with peak ebb/flood, but try to avoid submergence of surface buoy...may also use buoyancy elements mid-way up tether. Distance to Buoy 10 is 800 ft. Offset 1,000 ft from nearest PNL acoustic beacon. Sampling on all CTD "elements" = every 0.5 hour; or 0.25 hour based on 2-5 minute averaging duration.

Station 4: 9 ft Tripod with USGS Instruments, Tripod "A" SLOPING SEABED and sand waves. Offset 1,000 ft from nearest PNL acoustic beacon. Wave Burst ADVO data = 17 Min duration@2Hz every 0.5 hour

Station 5: 9 ft Tripod with USGS Instruments, Tripod "B". This is a high traffic corridor for shallow draft vessels transiting MCR, need to minimize anthrop. Interference. Sand wave effect is unknown here. Near surface CTD element to be placed on buoy line. Wave Burst ADVO data = 17 Min duration@2Hz every 0.5 hour

Dredging at MCR will cease by 24:00, 31 July and resume 6 August. On 10 August, 24:00 MCR dredging will cease and resume about 20 August. No Dredging should occur near Mega-Transect during deployment period of 6 August – 6 September. 90

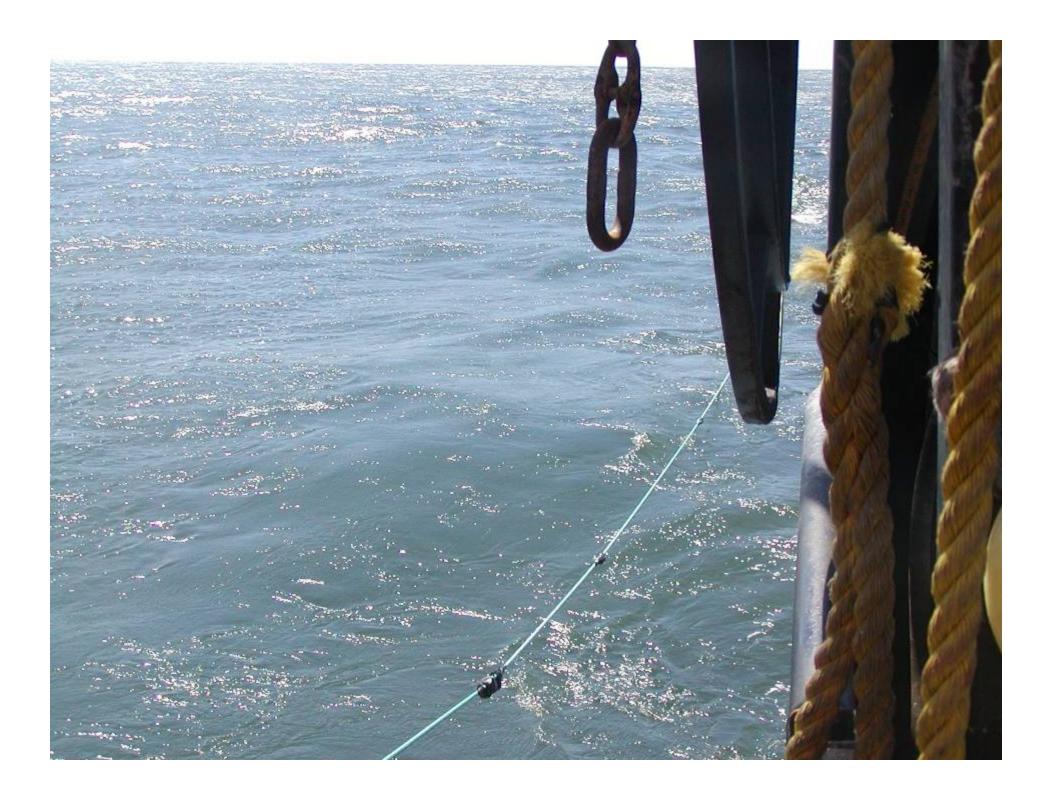
Cross-Section View Across MCR along Mega-Transect Area



View Upstream, Toward East

















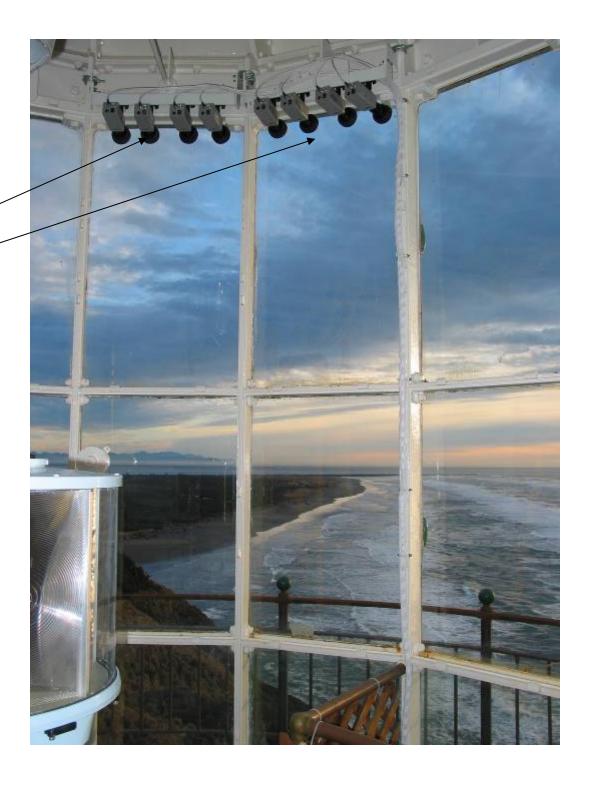


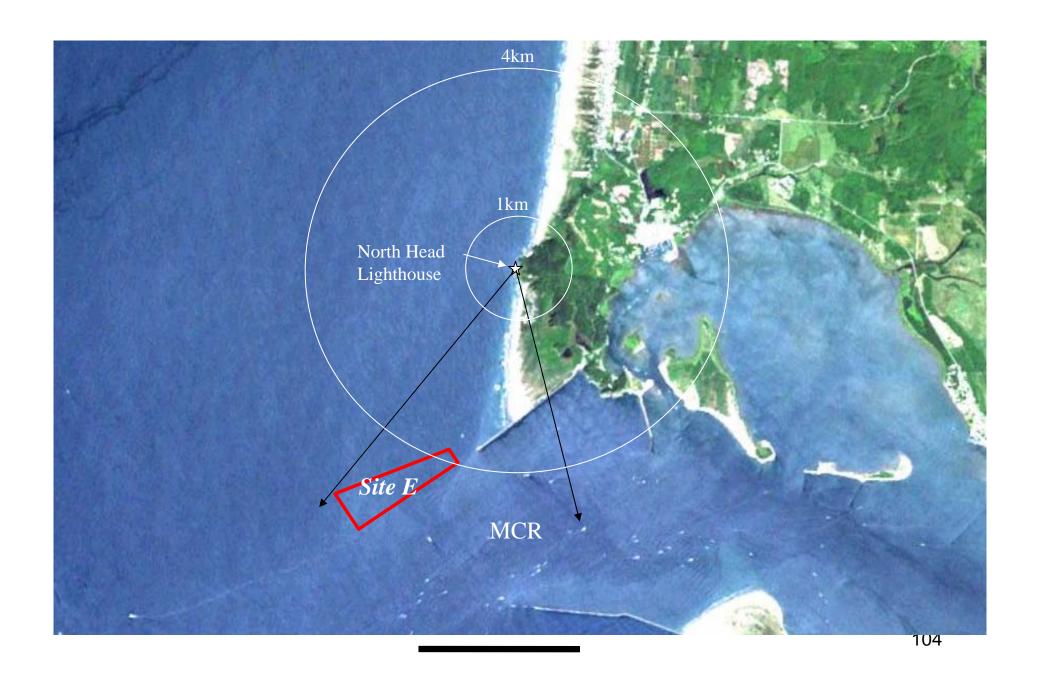




ARGUS Cameras

http://zuma.nwra.com/north_head/

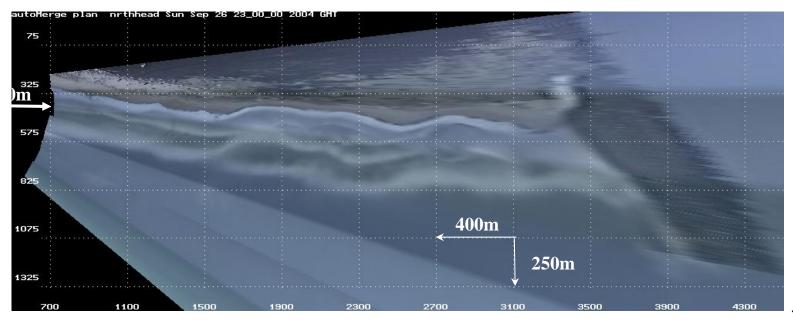




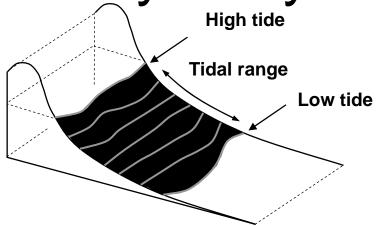






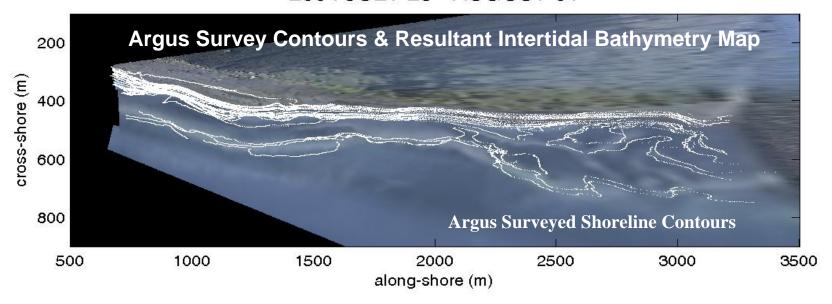


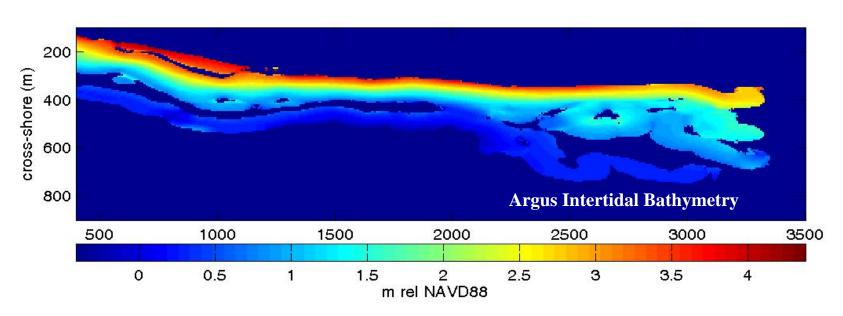
Mapping intertidal beach bathymetry

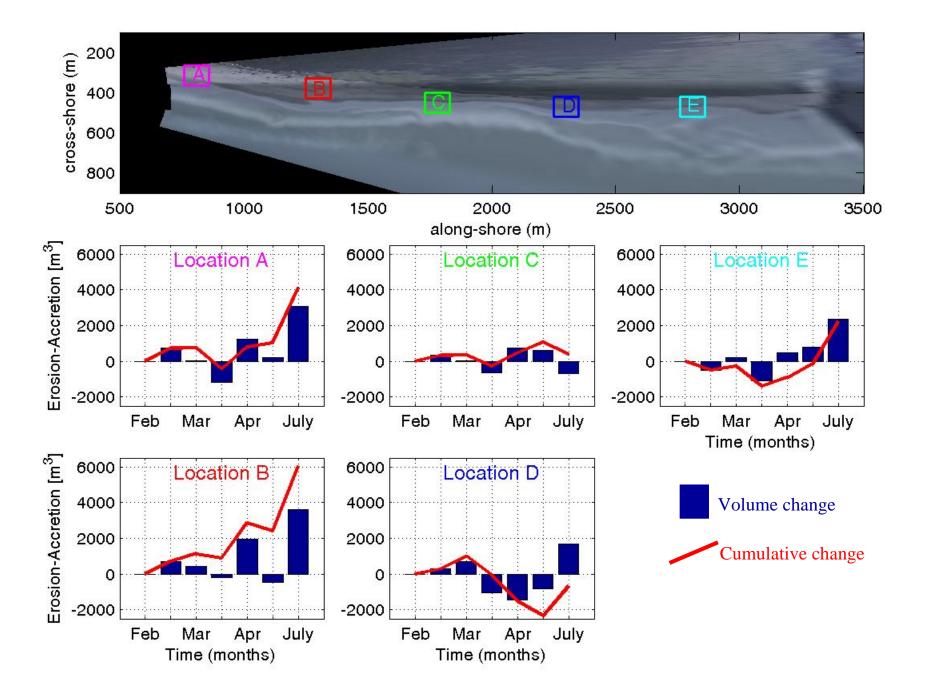


- Map intertidal beach bathymetry from set of waterlines sampled over tidal cycle
- Identify horizontal location of waterline from video
- Find corresponding elevation of waterline from hydrodynamic conditions

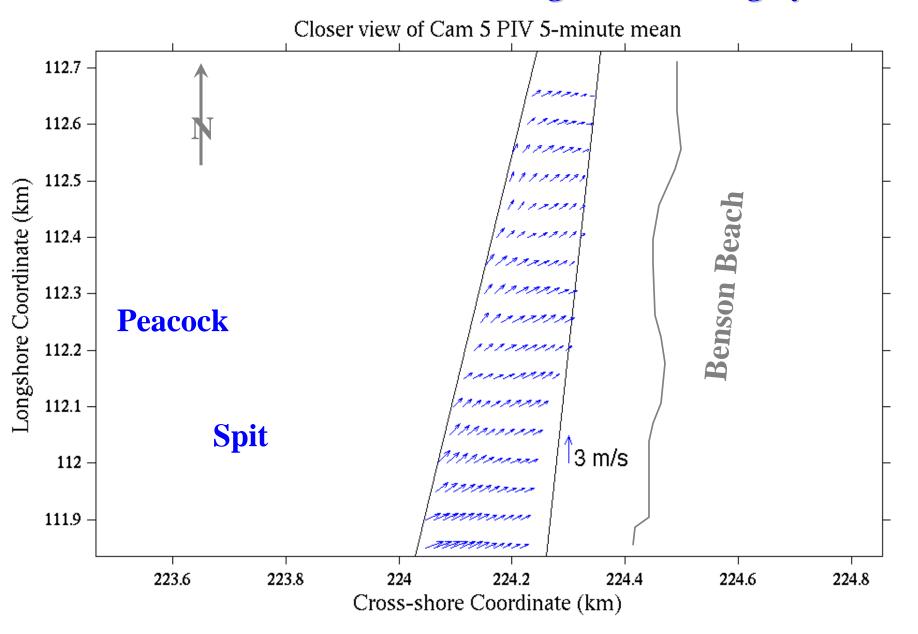
2004 JULY 28 - AUGUST 01







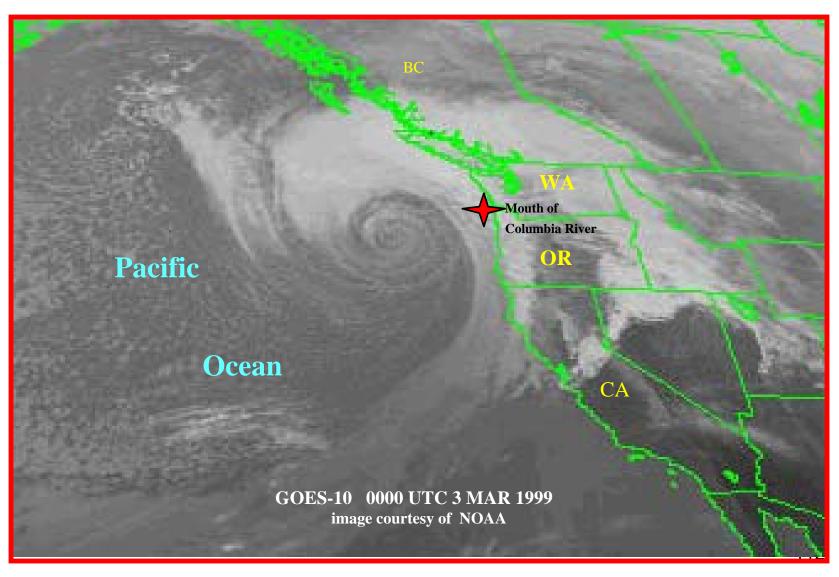
Surface Current Estimate Using ARGUS Imagery

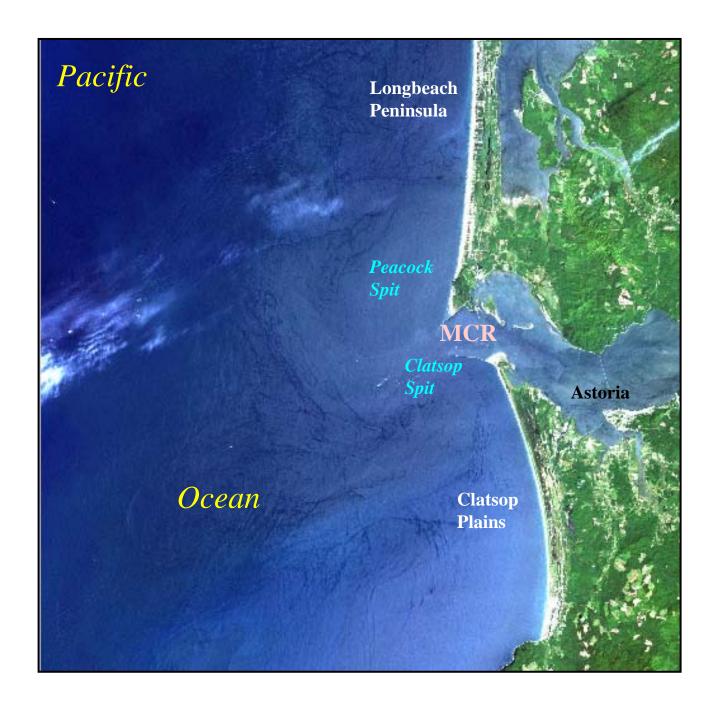


MCR Environment

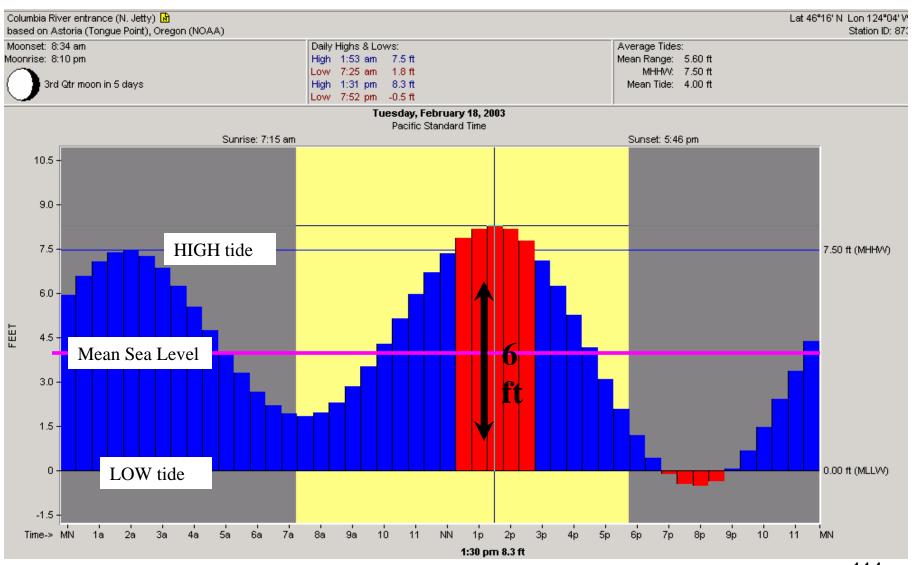


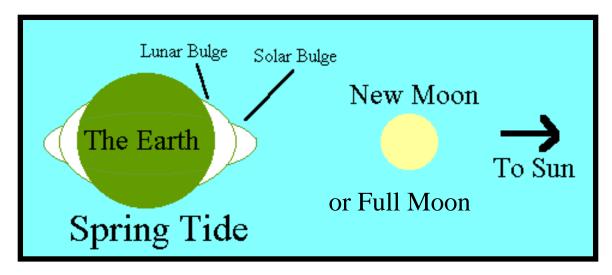
Severe Storm Climate during 1993-2002

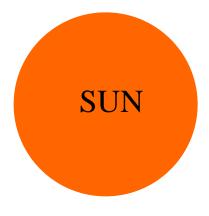


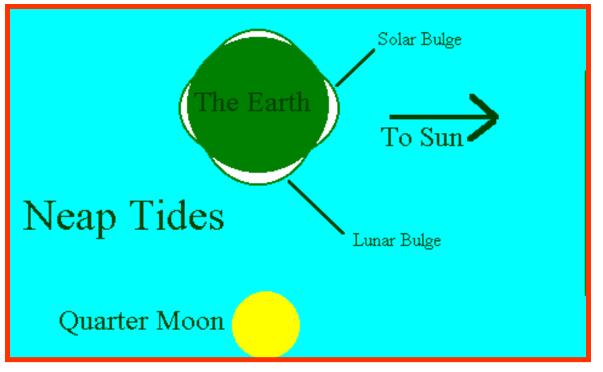


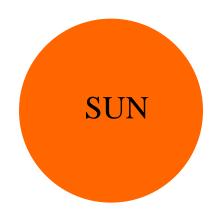
TIDE on NW PAC Coast is Semi-Diurnal: Two tides/day









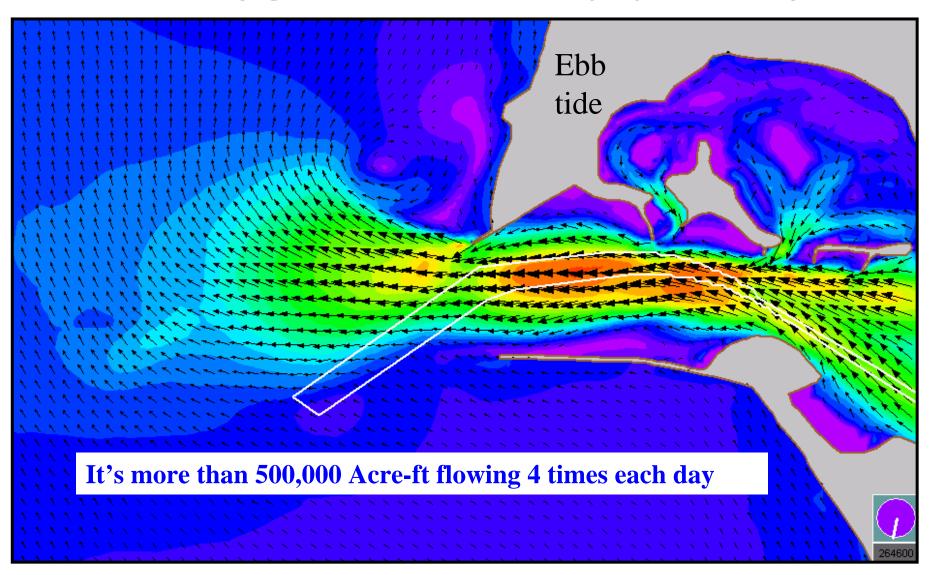


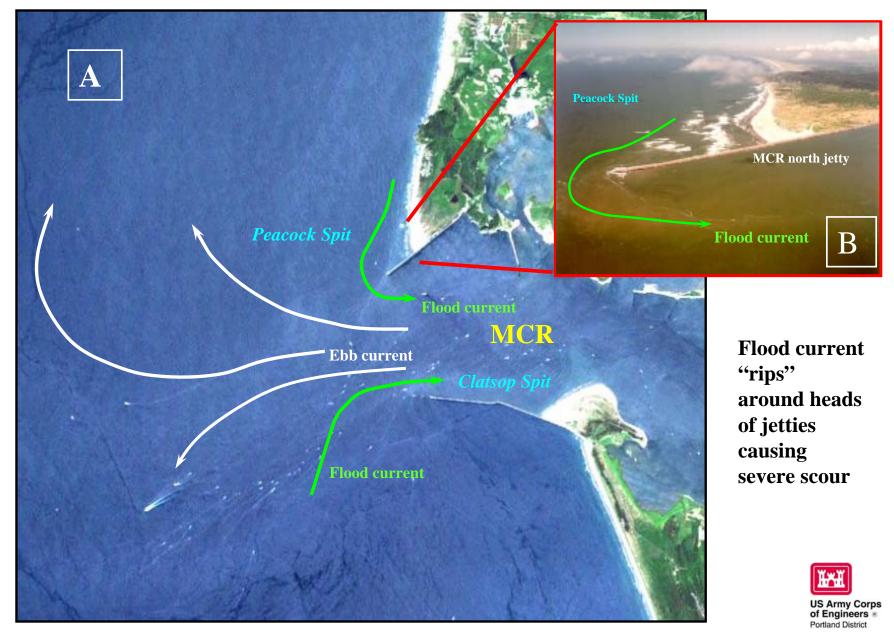




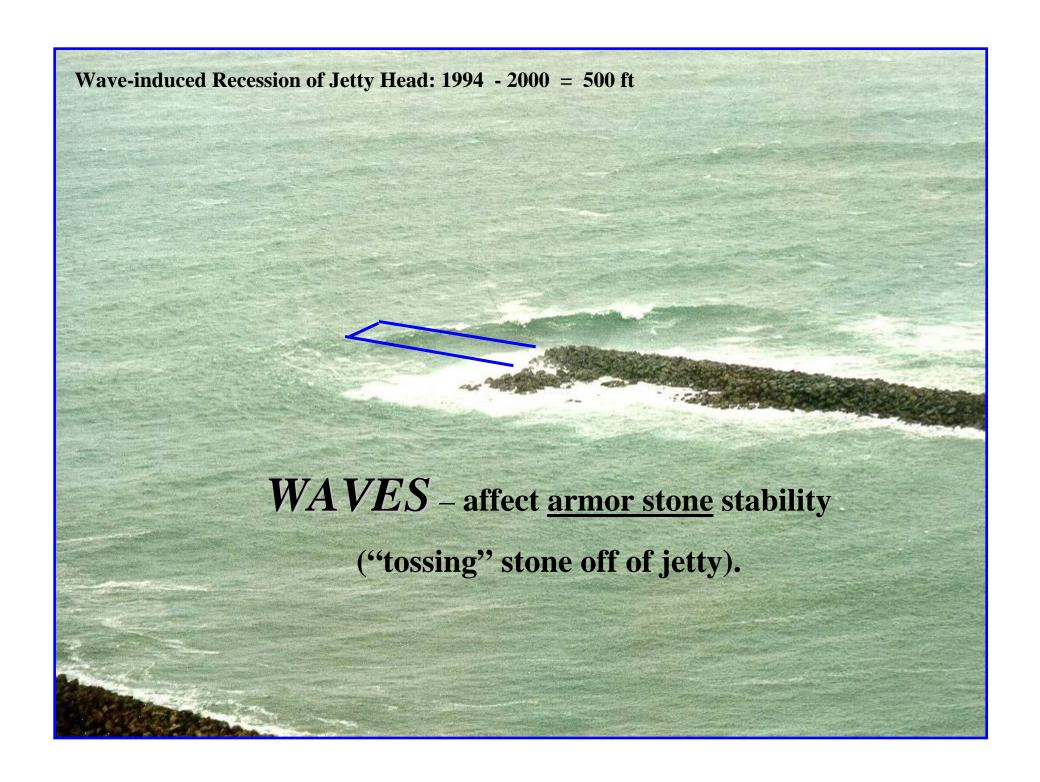
Currents Generated by TIDES and River - MCR

1.5 million cfs goes in & out, two times every day: current > 8 ft/sec



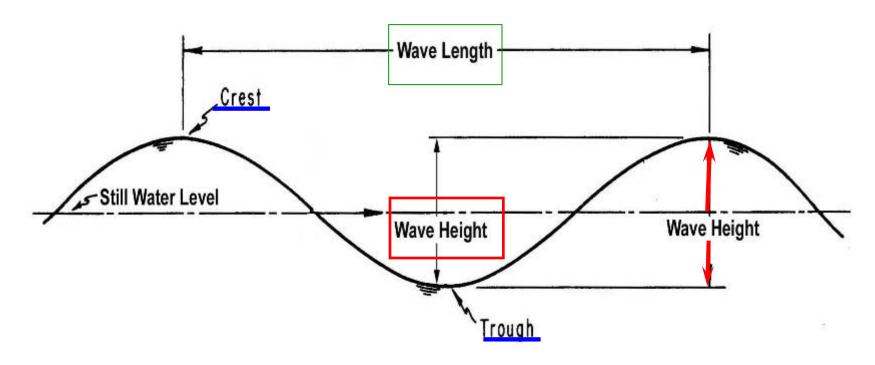








WAVE Geometry

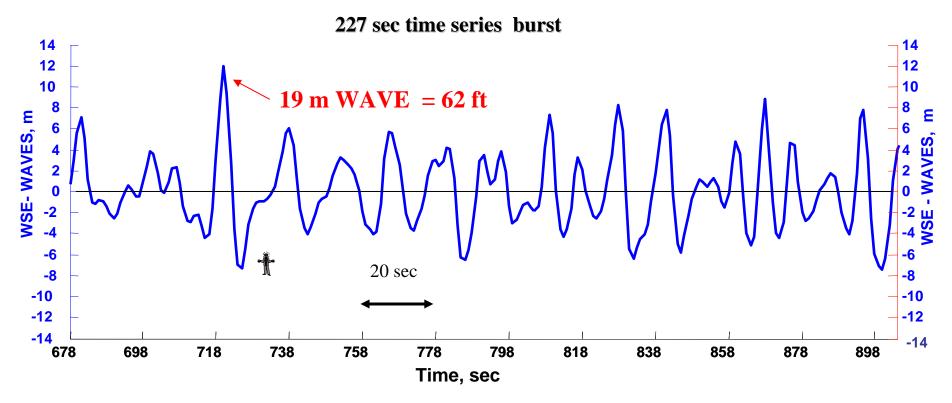


Wave <u>height</u> = vertical distance from trough to crest

Wave *Length* = horizontal distance from crest to crest

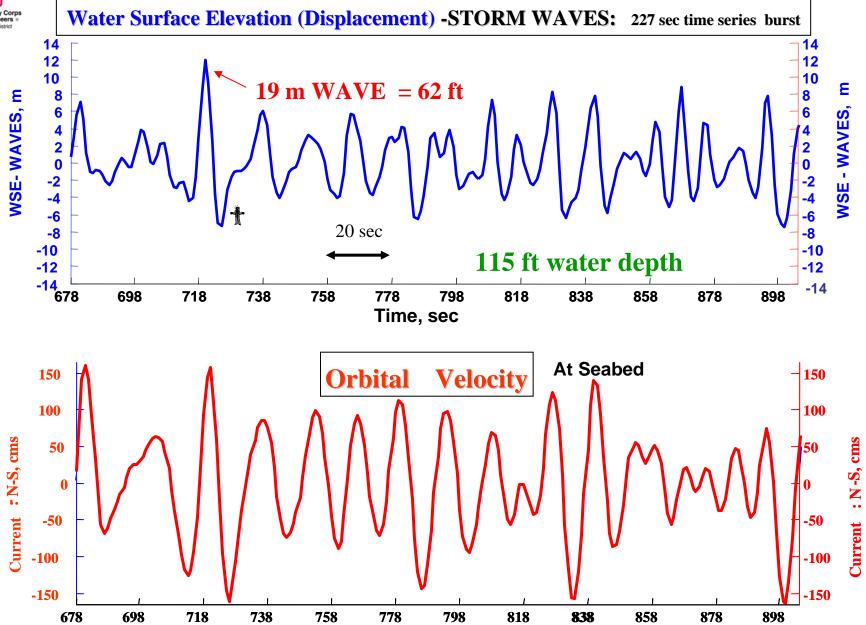
Wave **Period** = Time between passage of successive crests

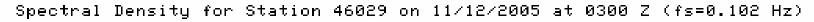
Water Surface Displacement -STORM WAVES

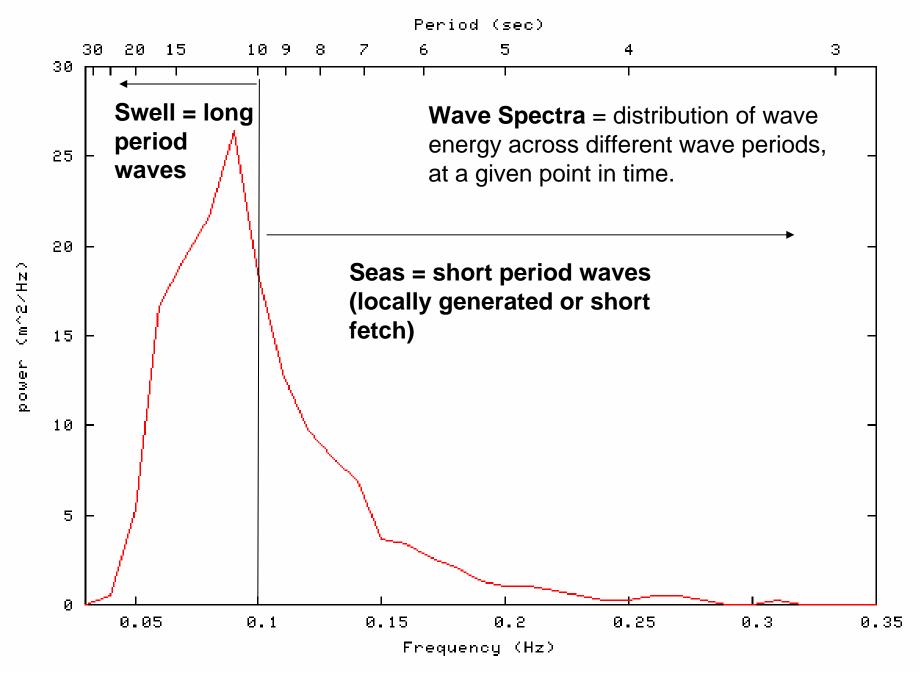


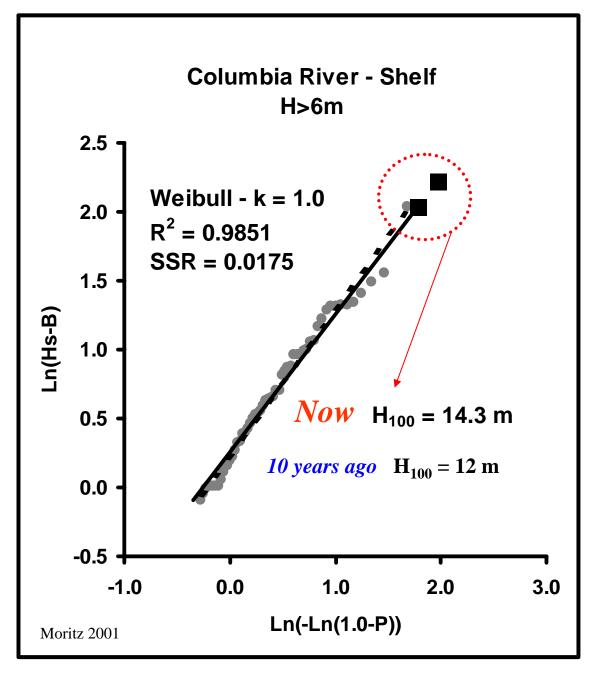
Energy = $1/8 \rho gH^2$ Power = Energy Flux = 2,000 Hp/ft of wave









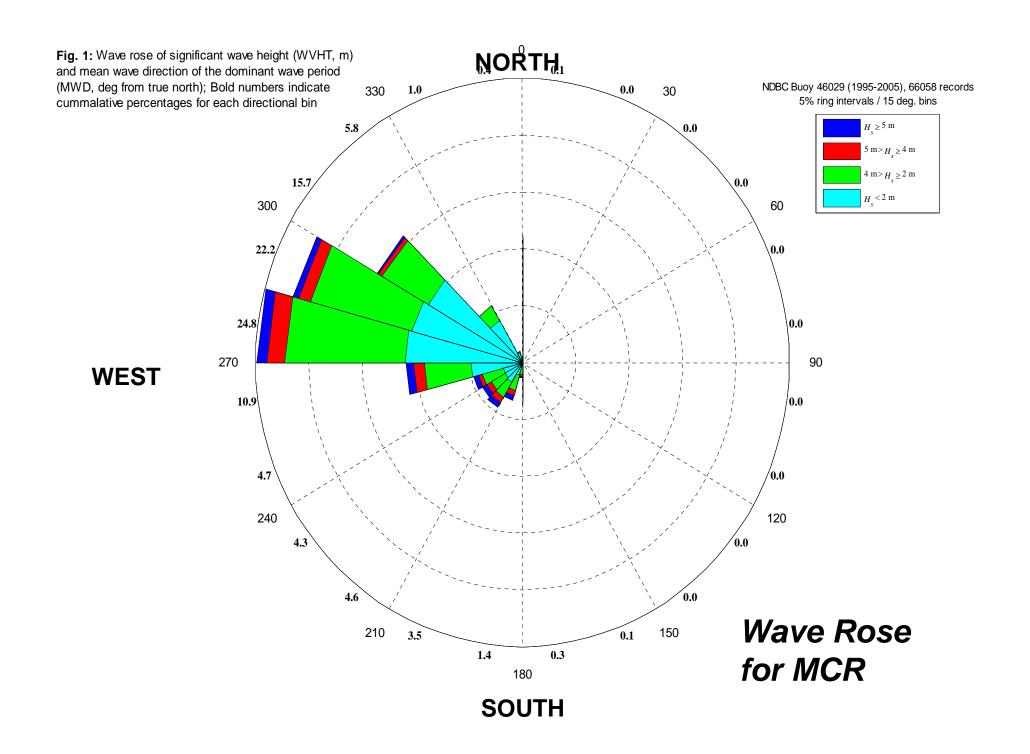


OFFSHORE

Wave Climate on the NW PAC Coast has become More SEVERE in the last 10 years: El Nino, La Nina, decadal oscillation

Design Wave needs to be Revised





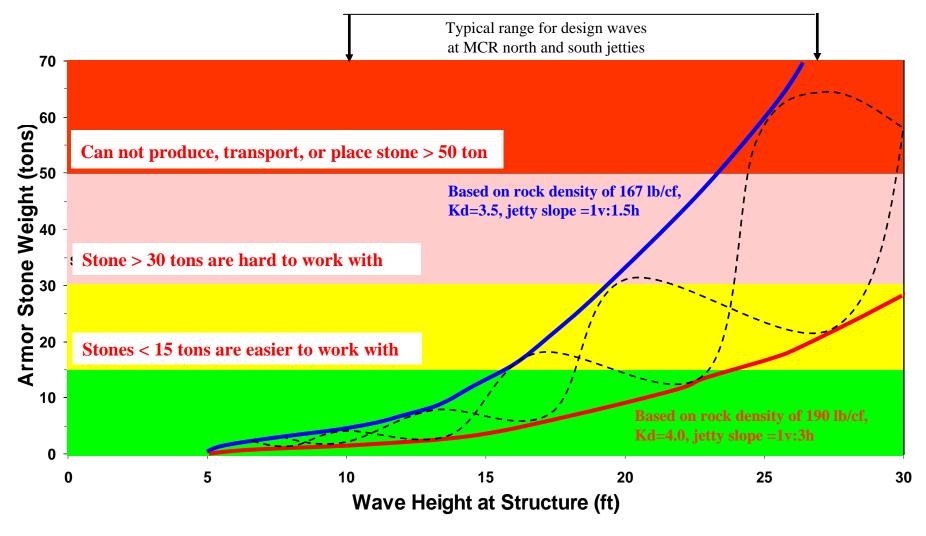


Figure 29. Functional relationship between wave height (H) at jetty and required armor stone size (W), based on the Hudson Equation. Results are shown for two different scenarios based on a variation in rock density (γ) , stability number (Kd), and jetty side slope (θ) . The two scenarios effectively define the envelope available for optimizing armor stone size, based on the above design parameters.



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Center of Excellence in Marine Technology



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New! - Tropical Atmosphere Ocean (TAO) Data Now Available

Columbia River Recent Marine Data

Not All Stations Depicted are Operated by the National Data Buoy Center.

To view marine data, click a station on the map below:





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Dial-A-Buoy

Publications Mariners Weather Log New! - Tropical Atmosphere Ocean (TAO) Data Now Available

Station 46029 - COL RIVER BAR - 78NM South Southwest of Aberdeen, WA

Owned and maintained by National Data Buoy Center

3-meter discus buoy

DACT payload

46.12 N 124.51 W (46°07'00" N 124°30'36" W)

Site elevation: sea level

Air temp height: 4 m above site elevation

Anemometer height: 5 m above site elevation

Barometer elevation: sea level

Sea temp depth: 0.6 m below site elevation

Water depth: 128.0 m

Watch circle radius: 130 yards

"Potential Explosion Hazard Exists for this Buoy"

Latest NWS Marine Forecast

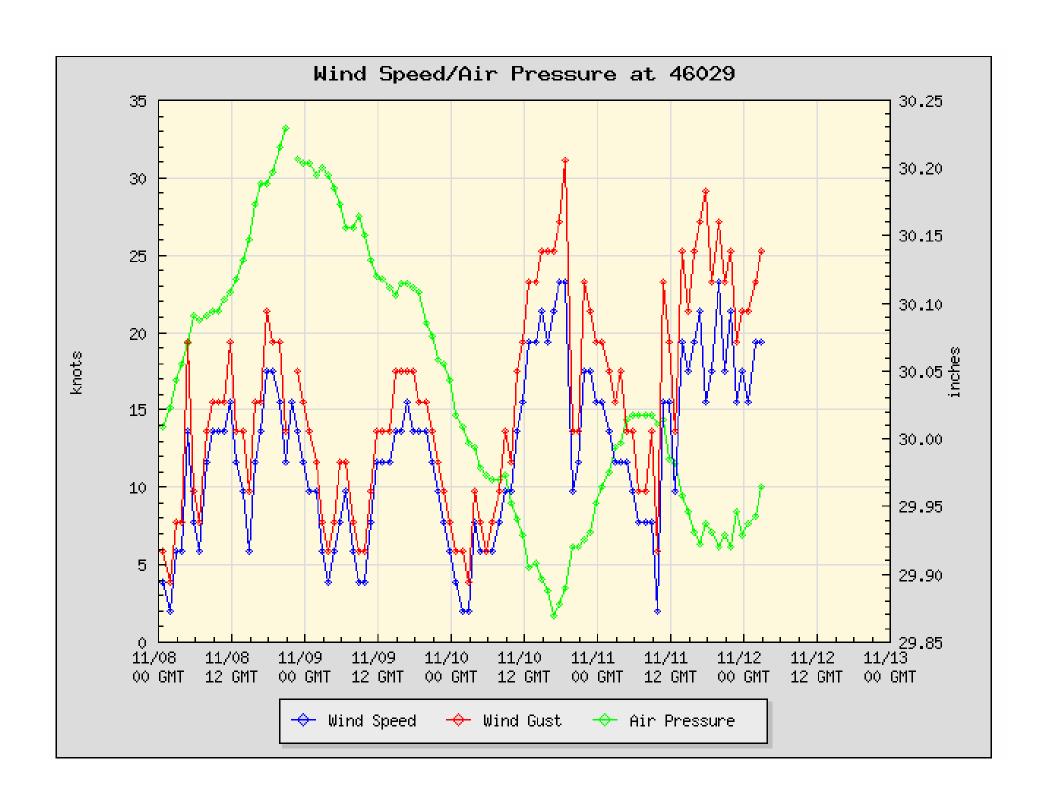
Important Notice to Mariners

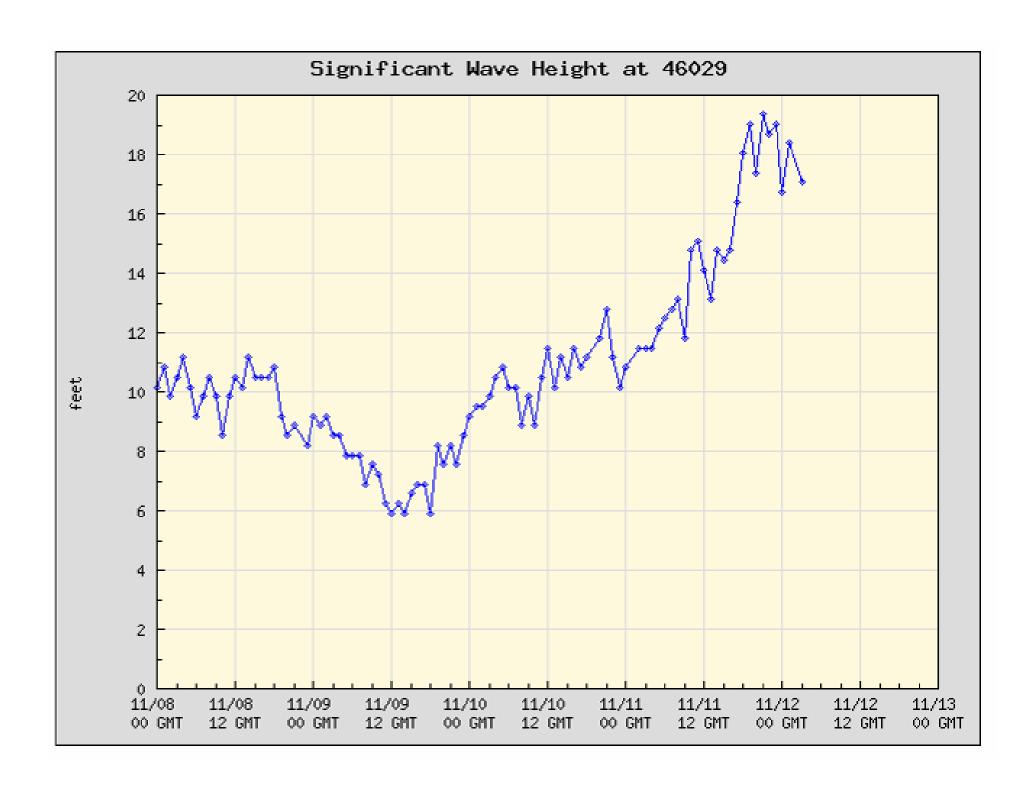
Search And Rescue (SAR) Data

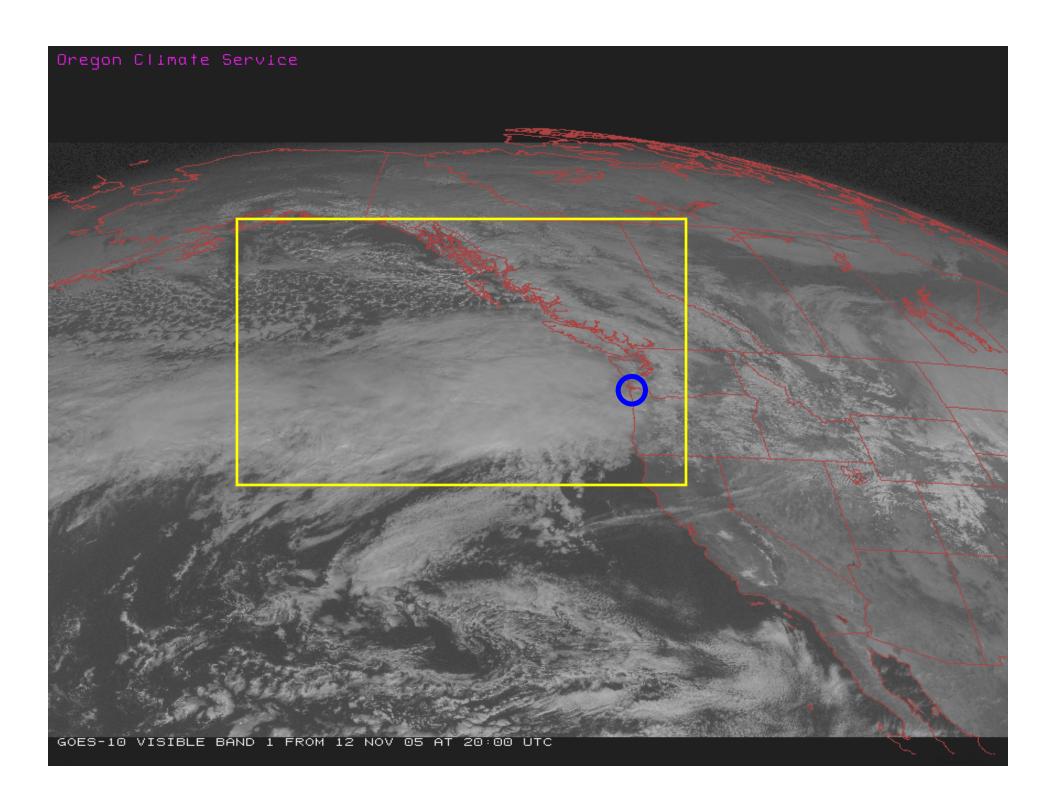
Meteorological Observations from Nearby Stations and Ships

Latest Satellite Wind Map for this Area









Snap-shot of Surface Winds over NE Pacific Ocean – Satellite Derived

